GEI Consultants, Inc.

INSTRUMENTATION APPENDIX TO PERIODIC INSPECTION REPORT NO. 5 HOPKINTON LAKE DAM HOPKINTON, NEW HAMPSHIRE

Submitted to:

Department of the Army
New England District
Corps of Engineers

1021 Main Street
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(781) 721-4000

November 1997
Project 97487

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Gillian Gregory

Gillian M. Gregory, Ph.D.
Project Manager

EXECUTIVE SUMMARY

This report provides a summary and evaluation of geotechnical instrumentation of the Hopkinton Lake Dam in Hopkinton, New Hampshire. The Hopkinton Lake Dam was constructed for flood control purposes and is a rolled earth fill with rock slope protection.

Geotechnical instrumentation at the dam consists of eight crest monuments, 22 piezometers, and seventeen tilt plates. The tilt plates are discussed in a separate report prepared by the Corps of Engineers (COE). In addition, there are also eight relief wells located on the downstream berm. Plate 2 shows the locations of the geotechnical instrumentation.

Crest Monuments

Eight crest monuments (Mons. 1 through 8) were installed in September 1985. There are also four control points labeled "SCOTT", B(H514), C, and D composed of brass discs set in ledge or concrete. Surveys for horizontal control were performed by the COE in 1986, 1991, and 1996. Vertical movement surveys were performed in 1985, 1986, 1991, and 1996. Survey data are presented on Plates 12 and 13. Computed horizontal and vertical movements were small with a range of horizontal movement from 0.010 to 0.037 foot (0.1 to 0.4 inch) between 1991 and 1996. Given the fact that visual inspections by the COE have shown no evidence of adverse movements at the dam, this amount of movement is not considered significant. The maximum net vertical movement recorded since 1985 is 0.082 foot (less than 1 inch) of settlement. This amount of settlement is close to the margin of error for the survey and thus is considered to be insignificant.

Piezometers

There are currently 22 piezometers installed at the dam. Five of these piezometers were installed since the last periodic inspection. These five piezometers were installed in three boreholes located along a cross section at about Station 5+25. Two piezometers were installed in a borehole located on the upstream slope, two in a borehole located on the downstream slope, and one in a borehole located on the downstream toe. The piezometer locations are shown on Plate 2. Table 1 gives the station, offsets, boring numbers, and elevations of key piezometer features. Plates 9, 10, and 11 give the engineering logs of the boreholes and piezometers. Plates 14 and 19 show a cross section through the dam at Station 5+25, showing the piezometer locations and piezometer data. Plates A.1 through A.48 show the boring logs, piezometer logs, and the results of the falling head tests on the piezometers. Data for the other 17 piezometers are shown on Plates 15, 17, and 18.

The COE project personnel measured piezometer pore water elevations according to the reading schedule shown on Plate B.3 from January 1992 through April 1997. Table 2 lists measured pore water depths in the piezometers from January 1992 through April 1997. Table 3 lists measured pore water elevations in the piezometers from January 1992 through April 1997. Table 3 data are plotted as time histories on Plates C.1 through C.6. Plates D.1 through D.6 contain the piezometer time history data for the high pool event in October 1996. Plates E.1 through E.22 show plots of piezometer pore water elevation vs. pool elevation.

An average piezometer pore water elevation was calculated for each piezometer based on the monthly data excluding the daily data collected during high pool periods. Table 4 lists the selected piezometer data used to calculate the average piezometer levels along with the calculated averages. Based on the plots of piezometer pore water elevation vs. pool elevation, projections were made of the likely piezometer pore water elevations for a flood pool at spillway crest. These projections are shown on Plates E.1 through E.22 and are listed in Table 8. Plates 15, 17, 18, and 19 show the average piezometer water levels, the maximum piezometer water levels recorded during the October 1996 high pool event, and the projected piezometer water levels for a flood reaching spillway crest for several cross sections and profiles.

Relief Wells

The COE project personnel measured relief well water elevations according to the reading schedule provided as Plate B.3 from January 1992 through April 1997. Table 5 lists measured water depths in the relief wells from January 1992 through April 1997. Table 6 lists measured water elevations in the relief wells from January 1992 through April 1997. Table 6 data are plotted as time histories on Plate F.1. Plate G.1 contains the relief well time history data for the high pool event in October 1996. Plates H.1 through H.8 show plots of relief well water elevation vs. pool elevation.

An average relief well water elevation was calculated for each relief well based on the monthly data excluding the daily data collected during high pool periods. Table 7 lists the selected relief well data used to calculate the average water levels along with the calculated averages. Based on the plots of relief well water elevation vs. pool elevation, projections were made of the likely relief well water elevations for a flood pool at spillway crest. These projections are shown on Plates H.1 through H.8 and are listed in Table 8. Plate 16 shows the average relief well water levels, the maximum relief well water levels recorded during the October 1996 high pool event, and the projected relief well water levels for a flood reaching spillway crest.

Conclusions and Recommendations

Based on past performance of the dam and on the performance of the instrumentation to date, the Hopkinton Lake Dam appears to be suitably instrumented. Existing instrumentation indicates that the dam embankment is functioning suitably relative to seepage and crest movements.

Comparison of data between 1991 and 1996 indicates horizontal displacements in the range of 0.010 to 0.037 foot (0.1 to 0.4 inch). The crest monument data show that movements are generally small and, taken together with past COE visual inspection reports indicating no evidence of adverse movements, can be considered insignificant. The maximum net vertical movement recorded since 1985 is 0.082 foot (less than 1 inch) of settlement. This amount of settlement is close to the margin of error for the survey and thus is considered to be insignificant.

The crest monuments should continue to be surveyed and evaluated on the current schedule of once every five years just prior to the periodic inspection.

We consider the number of piezometers installed to be adequate unless physical evidence of unusual seepage patterns observed in the future indicates the need for additional instrumentation.

The current schedule of monitoring the piezometers is adequate.

PREFACE

Purpose and Scope

This report provides a summary and evaluation of geotechnical instrumentation of the Hopkinton Lake Dam in Hopkinton, New Hampshire.

GEI performed the following work:

a) Reviewed Periodic Inspection Reports 1 through 5 and data provided by the U.S. Army Corps of Engineers (USACE) on August 19, 1997. (Tasks 1 and 2)

b) Prepared an instrumentation general plan in a Microstation drawing file. (Task 3)

c) Prepared drafted engineering logs and piezometer logs, profiles, and cross sections in Microstation drawing files. (Tasks 4 and 5)

d) Prepared Lotus 1-2-3 plots of piezometer data. (Task 6)

e) Prepared a phreatic surface plan in a Microstation drawing file. (Task 7)

f) Prepared survey data and horizontal and vertical movement plots in Microstation drawing files. (Task 8)

g) Prepared this report summarizing Tasks 1-8). (Task 9)

Project Personnel

Gillian M. Gregory	Project Manager
Carolyn Lewis	Civil Engineer
Dana MacLeod	Lead Drafter
R. Lee Wooten	In-House Reviewer

Elevation Datum

All elevations in this report are referenced to National Geodetic Vertical Datum (NGVD).

Limitations

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

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1. PROJECT PERFORMANCE

The dam performance is rated as good based on the instrumentation data compiled to date. Crest monument data indicate that horizontal displacements between 1991 and 1996 are in the range of 0.010 to 0.037 feet (0.1 to 0.4 inch). The maximum net settlement since 1985 is 0.082 foot (less than one inch). The piezometer readings, including the new piezometers, and dam performance indicate that the impervious central core is sufficient to lower the pore pressures and exit gradients so that seepage is safely exiting at the toe of the dam.

such as piping, boils, or sinkholes were observed then by the team or subsequently reported by the Project Manager.

c. March 1990 Pool: During March 1990, the embankment was subjected to its highest impoundment since piezometers 3 through 11 were installed in 1987 and 1988. The maximum water surface during this small event was at El. 397.2 feet NGVD, stage 31.2 (18.8 feet below the spillway crest).

d. August 1991 Pool: During the August 1991 event, the embankment was subjected to an impoundment of 394.6 feet NGVD, stage 28.6 feet (21.4 feet below spillway crest). The dam was inspected at the time by an Emergency Response Team from Geotechnical Engineering Division (GED). No abnormal seepage conditions such as piping, boils, or sinkholes were observed then by the team or subsequently reported by the Project Manager. During this time the forebay pool was empty (July 9 to October 24, for maintenance), which caused the water elevations in the piezometers and relief wells on the left side of the outlet channel to drop.

e. October 1996 Pool: During October 1996 the embankment was subjected to an impoundment of 403.2 feet NGVD, stage 37.2 feet (12.8 feet below spillway crest).

The instrumentation evaluation in this report is based on Piezometer 1 - 11 readings from 1992 to the present and Piezometers 13A and B, 14A and B and 15 from 1994 to the present. In addition, a review was made of piezometer data reported in the prior report (Ref. 4[1]).

[1] References are listed at the end of this report.

uplift development. The outlet works, located in the dam on the left bank of the river, consists of an approach channel, gate tower, three conduits, stilling basin, an outlet channel, and a forebay pool.

The Hoague-Sprague Dam located immediately downstream of the dam is used to supply water to the nearby paper mill.

The spillway is a concrete, trapezoidal weir (ogee section) founded on rock and is located in Dike H-3, located about 8,000 feet east of Hopkinton Dam (See Plate 1). Top elevation is El. 416 feet NGVD, and the crest length is 300 feet.

Instrumentation to monitor dam performance at Hopkinton Lake Dam consists of 8 crest monuments, 17 tilt plates, and 22 piezometers. There are also eight relief wells located along the downstream berm. A general plan of instrumentation is shown on Plate 2. There is no instrumentation at dikes H-2 and H-3.

Boring logs and piezometer installation logs are shown on Plates A.1 through A.48. Graphic logs for the three borings and five piezometers are shown on Plates 9-11. The piezometers are Casagrande-type with 3/4 inch, PVC riser pipe and are manually read using an M-Scope Water Level Indicator.

Piezometer data, including piezometer location (station and offset), piezometer tip and tip elevation, and the zone/material where the tip is located, are included in Table 1.

3.3 Relief Wells

There are connected deposits of laminated fine sand and clay and stratified sands and gravels within and under the glacial till (Plates 4A and 4B). The relief wells were installed during construction of the dam to relieve potential development of hydrostatic pressures in the deposits within and under the till. The wells are 8 inches in diameter, approximately 74 feet deep, and discharge into the rockfill adjacent to the forebay pool. The wood stave screens are 24 feet in length and surrounded by 40 feet of gravel pack. A detail of the wells is shown on Plate 25. The location plan is shown on Plate 2. The water surface in each well is read with an M-Scope Water Level Indicator.

3.4 Tilt Plates

Seventeen tilt plates were installed in 1989 to monitor the movement of the east outlet channel and stilling basin retaining walls. Tilt plate data obtained through 1996 were reported and evaluated by COE in Ref. 5.

attributed to the survey accuracy or natural soil adjustment. The 1996 survey showed random movement between 1991 and 1996 in the upstream direction of Mons. 1, 2, 3, 7, and 8, where Mons. 4, 5, and 6 showed slight movement in the downstream direction. In any event, the small amount of movement recorded and the lack of any other manifestation of movement of the embankment leads to the conclusion that no significant movement of the dam is occurring at this time. From the data that have been acquired to date, it is concluded that there has been insignificant horizontal movement within the embankment, and any recorded movements are probably due to instrument error.

4.2 Piezometers

4.2.1 Data Collection

a. Location Maps: A general plan of the project showing the location of the active piezometers and the corresponding identification number for each piezometer is provided to project personnel to eliminate identification and data recording inaccuracies.

b. Data Collection Tables: A table listing the piezometer identification number, stationing and offset, as well as piezometer top and tip elevations is also provided for recording and submitting piezometer readings.

c. Reading Schedule (See Plate B.3): Piezometer monitoring at Hopkinton Lake Dam has been maintained by project personnel since the installation of the piezometers in 1987. The minimum piezometer reading schedule presently in effect is as follows:

(1) Routine: During periods when the reservoir is at or below the 22-foot stage (El. 387.5 feet NGVD), readings should be made by the project manager at least once a month. When access to instruments is made hazardous by snow or ice, the readings may be deferred until safe access is possible.

(2) High Pool: During periods when the reservoir level (includes rising and falling pools) is above the 22-foot stage, readings should be made on a daily basis. Pool elevations should be recorded simultaneously with

piezometer, relief well, and tail water pool readings. On a falling pool, piezometer readings should continue for approximately five days after the pool has returned to its normal elevation.

level in PZ-1 ranges from El. 363.5 to about El. 369 for the period 1992 to 1997 (Plate C.1). This compares to elevations of 364 to 367 reported for the period 1987 to 1991 (Ref. 4). The reading of El. 375.4 on April 3, 1993 (Table 3) appears to be an error. Inspection of the depth readings for that date (Table 2) shows that the readings for PZ-1 and PZ-2 were probably reversed on the data sheets. According to the prior report (Ref. 4), the foundation drain under the stilling basin, where PZ-1 and PZ-2 tips are located, is directly connected to the tailwater by an outlet into the stilling basin at El. 363.0, and the piezometric level in PZ-1 tends to respond more to tailwater than to pool level. The piezometric level in PZ-1 does increase in response to rise in pool level, but the response is somewhat dampened. Plate D.1 shows the piezometric response to the pool level and the spillway discharge during the October 1996 flood, the response being similar to that of the 1987 flood (Plate 18, Ref. 4). Plate E.1 shows the piezometric level plotted against pool elevation. The plot shows a projection of piezometric level for a pool at spillway crest. The projected elevation for pool at spillway crest for PZ-1 is 369.4.

(2) PZ-2: PZ-2 is also located on the downstream side of the dam adjacent to the stilling basin's west wall with its tip at El. 330.0. This piezometer is similar to PZ-1 in construction (Plate 25) and response to a rising pool. Normal water level in PZ-2 from 1992 to 1997 also ranges from El. 363.5 to about El. 369, compared to 364 to 367 for the period 1987 to 1991 (Plate C.1). The reading of El. 358.8 on April 3, 1993 (Table 3) appears to be an error as explained above. Response of PZ-2 to rising pool and spillway discharge is also similar to PZ-1 (Plate D.1). The projected piezometric level in PZ-2 with pool level at spillway crest is 369.3 (Plate E.2).

(3) PZ-3A: PZ-3A is located on the downstream berm, near the left abutment with its tip in foundation soils at El. 305.7. The tip is surrounded by filter sand extending from El. 303.5 to 321.2, which is capped with a 4.5-foot bentonite seal. The foundation material that influences the response of PZ-3A is a gray silty (25-35%) SAND with gravel (5-15%) with large cobble fragments (SM). The normal groundwater level in PZ-3A ranges from El. 375 to El. 377 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 375.5 to 377.0 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 379.2 (Plate E.3).

capped with a 5.0-foot bentonite seal. The foundation material that influences the response of PZ-7A is a gray-brown silty (10-20%) GRAVEL with sand (5-15%) and rock fragments (GM). The normal groundwater level in PZ-7A ranges from El. 368.2 to El. 371 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 369 to 371 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 372.9 (Plate E.7).

(8) PZ-8A: PZ-8A is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 305.5. The piezometer tip is surrounded by filter sand extending from El. 304.5 to 320.8, which is capped with a 10.7-foot bentonite seal. The foundation material that influences the response of PZ-8A is a gray-brown silty (23-30%) SAND with gravel (SM). The normal groundwater level in PZ-8A ranges from El. 367 to El. 370 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 368 to 370 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusually high reading recorded on 2/5/96 appears to be the result of transposing the data for PZ-8A and PZ-8B on the data sheets. The projected piezometric elevation with pool level at spillway crest is 372.1 (Plate E.8).

(9) PZ-15: PZ-15 is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 301. The piezometer tip is surrounded by filter sand extending from El. 299 to 334, which is capped with a 6-foot bentonite seal. The foundation materials that influence the response of PZ-15 are stratified silty sands with rock fragments (SM) and some varved clay. The normal groundwater level in PZ-15 ranges from El. 370 to El. 377 over the period 1994 to 1997 (Table 4). It is not clear why there was a significant drop in piezometric level during August and September 1994. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 378.1 (Plate E.9).

(10) PZ-3B: PZ-3B is located on the downstream berm, near the left abutment, with its tip in foundation soils at El. 349.7. The piezometer tip is

(13) PZ-6B: PZ-6B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.9. The piezometer tip is surrounded by filter sand extending from El. 348.9 to 358.9, which is capped with a 3.6-foot bentonite seal. The foundation material that influences the response of PZ-6B is a gray, silty (28%) SAND with clay (10%) and gravel (5%) (SM). The normal groundwater level in PZ-6B ranges from El. 378.5 to El. 380.5 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 378 to 380 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.9 (Plate E.13).

(14) PZ-7B: PZ-7B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.2. The piezometer tip is surrounded by filter sand extending from El. 348.2 to 359.2, which is capped with a 2-foot bentonite seal. The foundation material that influences the response of PZ-7B is a gray, silty (15%) clayey (14%) SAND with gravel (23%) (SC-SM). The normal groundwater level in PZ-7B ranges from El. 378.5 to El. 380.8 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 378 to 381 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.9 (Plate E.14).

(15) PZ-8B: PZ-8B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.5. The piezometer tip is surrounded by filter sand extending from El. 348.5 to 358.5, which is capped with a 6-foot bentonite seal. The foundation material that influences the response of PZ-8B is a gray, sandy (43%) SILT with clay (18%) and a trace of gravel (ML). The normal groundwater level in PZ-8B ranges from El. 379.5 to El. 382 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 379 to 381 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.4 (Plate E.15).

(19) PZ-13A: PZ-13A is located on the upstream slope of the embankment with its tip in foundation soils at El. 299. The piezometer tip is surrounded by filter sand extending from El. 297 to 315, which is capped with a 6-foot bentonite seal. The foundation materials that influence the response of PZ-13A are a dark gray, silty (25-35%) SAND with gravel (15-25%) (SM) and a brown sandy 30-40%) CLAY with little gravel (CL). The normal groundwater level in PZ-13A ranges from El. 370 to El. 373 over the period 1994 to 1997 (Table 4). The time-history plots (Plates C.5 and D.5) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusually high reading on 4/30/96 may be the result of transposing the depths recorded for PZ-13A and PZ-13B. The projected piezometric elevation with pool level at spillway crest is 375.3 (Plate E.19).

(20) PZ-14A: PZ-14A is located on the downstream slope of the embankment with its tip in foundation soils at El. 303. The piezometer tip is surrounded by filter sand extending from El. 300 to 320, which is capped with a 6-foot bentonite seal. The foundation material that influences the response of PZ-14A is a brown clayey (10-20%) SAND with gravel (15-25%) (SC). The normal groundwater level in PZ-14A ranges from El. 369.2 to El. 372 over the period 1994 to 1997 (Table 4). The time-history plots (Plates C.5 and D.5) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusual reading on 4/30/96 may be the result of transposing the depths recorded for PZ-14A and PZ-14B. The projected piezometric elevation with pool level at spillway crest is 374.2 (Plate E.20).

(21) PZ-13B: PZ-13B is located on the upstream slope of the embankment with its tip near the boundary between embankment and foundation soils at El. 368. The piezometer tip is surrounded by filter sand extending from El. 366 to 374, which is capped with a 4-foot bentonite seal. The foundation materials that influence the response of PZ-13B are a dark gray. silty (25-35%) SAND with gravel (15-25%) (SM) and a brown sandy (30-40%) CLAY with little gravel (CL). The normal groundwater level in PZ-13B was difficult to estimated due to the scatter in the data (Table 3 and Plate C.6). The time-history plots (Plates C.6 and D.6) appear to indicate piezometric levels higher than pool level. An unusually low reading on 4/30/96 may be the result of transposing the depths recorded for PZ-13A and PZ-13B. Also, the readings for PZ-13B and PZ-14B may have been

typically about 5 feet higher than in the other deep piezometers to the right of the stilling basin. This may indicate that these two piezometers are founded in similar strata or that PZ-3A is influenced by the abutment and PZ-15 is influenced by recharge from relief well RW-2. Relief Well RW-2 is closer to PZ-15 than any other relief well is to an adjacent piezometer. Therefore, it is possible that there would be a recharge effect at PZ-15 that might not be evident at other piezometers. Average readings for PZ-5B, PZ-6B, PZ-7B, and PZ-8B are in the range of 379 to 381 over the past five years.

Piezometers PZ-3A&B and PZ-4A&B are located to the left of the outlet and stilling basin. Piezometric levels in the deep piezometers to the left of the outlet appear to be about 2 to 5 feet higher than the levels in the deep piezometers to the right of the outlet and stilling basin. Piezometric levels in PZ-4B are about 2 feet lower than in PZ-4A, indicating that the levels in PZ-4B appear to be influenced by the foundation drains for the adjacent stilling basin. Piezometric levels for PZ-3A and PZ-3B are very similar over the five years. The level in PZ-3A is 5 to 7 feet higher than for the deep piezometers in the valley bottom, indicating some influence from the left abutment. The level in PZ-3B is 3 to 5 feet lower than for the shallow piezometers in the valley bottom, indicating less of a connection with the forebay reservoir.

(2) Station 5+25: Piezometers PZ-13A&B, PZ-14A&B, and PZ-15 were installed during 1993 at approximately Sta. 5+25 (Plate 19). Time history data are shown together on Plates C.5 and D.5 for the past four years and for the high pool event, respectively. Normal piezometric levels in deep piezometers PZ-13A and PZ-14A are close to or lower than pre-existing ground levels, indicating that there is not a significant artesian condition in the gravels underlying the dam. As described above, PZ-15 may be influenced by RW-2, resulting in higher piezometric levels than in PZ-13A or PZ-14A. Piezometric levels in PZ-13B typically respond closely to fluctuations in the pool level as would be expected, although there is a lot of scatter in the data. Piezometric levels are generally about 5 feet higher in PZ-13B than in PZ-14B. As would be expected, the compacted pervious fill drain layer affects the response of PZ-14B, limiting piezometric levels to an elevation corresponding to the top of the drain layer (Plate 19).

4.3 Relief Wells

4.3.1 Data Collection

Water surface elevations for relief wells are collected in the same manner as the piezometer data as described in subsection 4.2.1. However, very little data have been collected since October, 1994. Relief well depths and elevations are given in Tables 6 and 7, respectively. Time-history plots of all eight relief wells are shown on Plate F.1. A time-history plot for the October 1996 high pool event is shown on Plate G.1. Relief well elevation vs. pool elevation plots are included as Plates H.1 - H.8.

4.3.2 Interpretation and Evaluation

Based on the soil profile, only RW-1, RW-4, and RW-8 intercept the gravel layer below the dam (Plate 16). The others are located in the glacial till. The strata surrounding RW-6 are questionable; the log for the relief well indicates a gravelly (water-bearing) river bed sand, while the adjacent boring log indicates glacial till.

During January 1994, the relief wells were flushed (Ref. 6). Up to 7.7 feet of sediment was removed from the wells. Based on drawings showing design well depths (Plates 16 and 25), it appears that between 0.5 and 3.5 feet of sediment may have remained at the bottom of the wells after flushing. This amounts to 2 to 15% of the well screen length compared to 25 to 50% reported for the prior periodic inspection (Ref. 4). It was stated in Ref. 4 that the gravel pack is of too fine a gradation for the well screens size, and thus it is possible that slightly more sediment is in the wells in 1997 than in 1994. It was also reported in Ref. 4 that inspection by a down-hole camera in 1992 had indicated a significant build-up of mineral deposits on the well screens that would restrict flow into the wells.

Relief wells 2 through 8 are located on the downstream toe berm to the left of the stilling basin outlet. They respond only slightly to rising pool elevation and generally remain at about El. 380 to 382 (Plate F.1). In addition, the water levels change only slightly when the pool was drawn down to El. 365 in mid-1993. The forebay pool elevation is generally at 381± feet. The T-invert outlet of RW-2 through RW-8 is at El. 375 according to as-built plans (Plate 25). With the forebay pool above the relief well outlet elevation, water from the forebay pool can back up into the relief wells. It would thus be difficult to determine whether any water is flowing into the relief wells from the underlying gravel layer.

5. CONCLUSIONS

5.1 General

Based on past performance of the dam and on the performance of the instrumentation to date, the Hopkinton Lake Dam appears to be suitably instrumented. Existing instrumentation indicates that the dam embankment is functioning suitably relative to seepage and crest movements.

5.2 Crest Monuments

5.2.1 Schedule

The planned schedule for crest monument surveys for the Hopkinton Lake Dam is once every five years, which coincides with the periodic inspection schedule. This schedule is adequate unless physical evidence of embankment movement is found or the next scheduled survey results in unusual readings. Therefore, the next scheduled survey should be performed in 2001, just prior to the periodic inspection.

5.2.2 Evaluation of Adequacy

The number and locations of the crest monuments are adequate to evaluate embankment movements. Comparison of data between 1991 and 1996 indicates horizontal displacements in the range of 0.010 to 0.037 foot (0.1 to 0.4 inch). Measured settlements since 1985 are less than 0.082 foot (1 inch). In the absence of any reported physical evidence to indicate embankment movement, these displacements and settlements are not considered significant.

5.2.3 Recommendations

The crest monuments should continue to be surveyed and evaluated on the current schedule.

5.3 Piezometers

5.3.1 Schedule

The current schedule of monitoring the piezometers is adequate.

dam, and thus the relief wells may not be needed. In addition, water levels in the forebay pool are higher than the T-invert outlets of the wells, and thus the wells may be acting as gravity injection wells, as indicated by piezometric levels at PZ-15.

5.4.3 Recommendations

The relief well water levels should continue to be recorded and evaluated on the current schedule.

TABLE 1 - PIEZOMETER DATA - MATERIAL ZONES
Instrumentation Appendix
Hopkinton Lake Dam, Hopkinton, New Hampshire

Piez. No.	Station	CL Offset (1) (feet)	Riser Pipe Top Elevation (feet-NGVD)	Piezometer Tip Elevation (feet-NGVD)	Zone	Material Tip Is Located In
PZ-1	5+58	213	376.3	331.00	Drain	Filter Sand
PZ-2	6+49	213	384.7	330.00	Drain	Filter Sand
PZ-3A	7+07	155	385.10	305.70	Foundation	Gray Silty SAND (SM)
PZ-3B	7+07	155	385.10	349.70	Foundation	Gray Silty SAND w/Clay (SC-SM)
PZ-4A	6+43	155	385.10	305.70	Foundation	Gray Br. Silty SAND w/Gravel (SM)
PZ-4B	6+43	155	385.10	349.70	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-5A	5+02	155	385.00	305.60	Foundation	Gray Sandy SILT (ML)
PZ-5B	5+02	155	385.00	349.60	Foundation	Gray Silty SAND w/Clay (SC-SM)
PZ-6A	4+50	155	385.30	305.90	Foundation	Gray Br. Silty SAND (SM)
PZ-6B	4+50	155	385.30	349.90	Foundation	Gray Silty SAND w/Clay (SM)
PZ-7A	4+02	155	384.60	305.20	Foundation	Gray Br. Silty GRAVEL (GM)
PZ-7B	4+02	155	384.60	349.20	Foundation	Gray Silty Clayey SAND (SC-SM)
PZ-8A	2+53	155	384.90	305.50	Foundation	Gray Br. Silty SAND w/Gravel (SM)
PZ-8B	2+53	155	384.90	349.50	Foundation	Gray Sandy SILT (ML)
PZ-9	5+47	275	384.80	340.50	Foundation	Gray SAND w/Silt (SP-SM)
PZ-10	5+28	318	384.70	323.80	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-11	5+08	357	384.10	353.10	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-13A	5+25	59	417.7	299.0	Foundation	Brown SAND w/Silt (SP-SM)
PZ-13B	5+25	59	417.8	368	Embankment	Dark Brown Sandy SILT, Trace Gravel (ML)
PZ-14A	5+25	73	417.7	303	Foundation	Brown Clayey Sand w/Trace Gravel (SC)
PZ-14B	5+25	73	417.8	369	Embankment	Brown, M-F SAND w/Trace Silt (SP)
PZ-15	5+25	155	384.3	301	Foundation	Gray Varved Clay w/M-F SAND (CL)

Note: (1) All piezometers are located downstream of the crest, except PZ-13A and PZ-13B.

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
01/31/92	382.70	6.36	3.88	2.74	2.79	4.38	5.28	4.84	1.08	4.81	1.58	4.50	1.34	4.96	0.91	6.27	5.00	5.75	NA	NA	NA	NA	NA
03/03/92	383.00	6.32	3.82	2.80	2.86	4.38	5.23	4.85	0.96	4.85	1.57	4.55	1.33	5.04	0.90	6.20	5.02	0.90	NA	NA	NA	NA	NA
03/12/92	388.96	5.42	2.91	2.36	2.54	3.80	4.59	4.36	1.18	4.40	1.42	4.25	1.29	4.74	1.90	5.40	4.42	4.70	NA	NA	NA	NA	NA
03/13/92	388.73	5.41	2.92	2.25	2.55	3.75	4.55	4.35	1.00	4.41	1.45	4.24	1.20	4.72	0.96	5.38	4.41	4.72	NA	NA	NA	NA	NA
03/14/92	386.90	5.43	2.92	2.21	2.56	3.71	4.55	4.33	1.04	4.43	1.51	4.26	1.22	4.72	0.90	5.34	4.36	4.71	NA	NA	NA	NA	NA
03/15/92	384.85	5.76	3.26	2.31	2.65	3.87	4.72	4.58	1.04	4.56	1.54	4.36	1.28	4.83	0.90	5.61	4.56	4.98	NA	NA	NA	NA	NA
03/16/92	385.12	5.76	3.26	2.41	2.69	3.97	4.90	4.55	1.00	4.60	1.52	4.40	1.27	4.95	0.90	5.69	4.63	5.05	NA	NA	NA	NA	NA
03/17/92	383.50	5.77	3.30	2.45	2.72	4.00	4.88	4.57	1.05	4.64	1.55	4.40	1.30	4.88	0.90	5.68	4.65	5.05	NA	NA	NA	NA	NA
03/18/92	382.48	6.14	3.65	2.59	2.78	4.20	5.07	4.73	1.08	4.74	1.64	4.49	1.38	4.94	0.90	6.02	4.88	5.25	NA	NA	NA	NA	NA
03/19/92	382.80	6.35	3.87	2.73	2.80	4.37	5.20	4.83	1.10	4.80	1.60	4.50	1.36	4.97	0.90	6.24	5.01	5.55	NA	NA	NA	NA	NA
03/20/92	382.60	6.40	3.90	2.87	2.81	4.40	5.24	4.86	1.10	4.83	1.64	4.53	1.38	4.97	0.90	6.27	5.04	5.55	NA	NA	NA	NA	NA
04/03/92	384.20	5.92	3.31	2.49	2.56	4.06	4.89	4.58	1.02	4.57	PI	4.33	1.25	4.78	PI	5.84	4.68	5.12	NA	NA	NA	NA	NA
04/30/92	380.98	5.80	3.33	2.43	2.36	4.03	4.85	4.67	1.71	4.72	1.92	4.40	1.65	4.88	1.58	5.75	4.71	5.16	NA	NA	NA	NA	NA
06/02/92	384.96	5.60	2.98	2.60	2.23	4.08	4.80	4.70	1.60	4.70	1.92	4.40	1.72	4.98	1.50	5.69	4.70	5.14	NA	NA	NA	NA	NA
07/01/92	380.15	6.39	3.90	2.90	2.80	4.50	5.30	5.03	1.73	5.02	2.05	4.71	1.80	5.20	1.60	6.32	5.15	5.75	NA	NA	NA	NA	NA
08/04/92	380.12	6.38	3.87	2.95	2.77	4.55	5.30	5.08	1.71	5.09	2.05	4.78	1.81	5.25	1.61	6.32	5.20	5.75	NA	NA	NA	NA	NA
09/01/92	380.00	6.38	3.88	3.00	2.82	4.55	5.33	5.11	1.71	5.12	2.08	4.82	1.85	5.32	1.63	6.33	5.23	5.71	NA	NA	NA	NA	NA
09/28/92	380.57	6.10	3.60	2.87	2.75	4.40	5.17	5.00	1.53	5.02	1.95	4.79	1.70	5.28	1.48	6.07	5.06	5.45	NA	NA	NA	NA	NA
10/30/92	382.12	6.35	3.86	3.00	2.82	4.57	5.33	5.11	1.15	5.15	1.60	4.87	1.34	5.45	1.08	6.31	5.18	5.62	NA	NA	NA	NA	NA
11/30/92	384.00	5.62	3.12	2.47	2.40	3.99	4.70	4.57	1.02	4.62	1.52	4.41	1.25	4.92	1.03	5.49	4.62	5.02	NA	NA	NA	NA	NA
12/31/92	384.00	6.00	3.50	2.70	2.75	4.23	5.02	4.75	0.90	4.77	1.42	4.50	1.12	5.03	0.90	5.91	4.85	5.40	NA	NA	NA	NA	NA
01/29/93	384.00	6.22	3.72	2.59	2.70	4.22	5.02	4.78	0.96	4.78	1.48	4.51	1.16	5.02	PF	6.03	4.93	5.50	NA	NA	NA	NA	NA
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA	NA	NA
03/31/93	393.50	5.34	2.85	2.23	2.40	3.79	4.31	4.23	0.95	4.26	1.35	4.04	1.09	4.59	0.85	5.30	4.28	4.80	NA	NA	NA	NA	NA
04/01/93	398.30	6.13	3.64	2.36	2.24	4.02	4.56	4.39	0.94	4.26	1.24	3.94	0.97	4.47	0.88	6.00	4.66	5.54	NA	NA	NA	NA	NA
04/02/93	402.50	5.44	2.95	2.22	2.15	3.75	4.38	4.18	PF	4.12	1.15	3.81	0.85	4.38	PF	5.45	4.27	4.99	NA	NA	NA	NA	NA
04/03/93	402.90	2.84	5.33	2.05	2.15	3.55	4.23	4.09	PF	4.09	1.15	3.80	0.83	4.37	PF	5.37	4.18	4.84	NA	NA	NA	NA	NA
04/04/93	402.40	5.10	2.62	1.92	2.19	3.42	4.12	4.03	PF	4.16	1.18	3.84	0.87	4.39	PF	5.07	4.06	4.60	NA	NA	NA	NA	NA
04/05/93	401.20	4.81	2.32	1.84	2.22	3.31	4.00	4.04	PF	4.14	1.22	4.01	0.92	4.58	PF	4.79	3.95	4.24	NA	NA	NA	NA	NA
04/06/93	400.10	4.80	2.29	1.82	2.26	3.28	4.00	4.01	PF	4.13	1.22	3.99	0.94	4.15	PF	4.78	3.95	4.25	NA	NA	NA	NA	NA
04/07/93	398.00	4.69	2.21	1.78	2.30	3.24	3.96	4.00	PF	4.12	1.31	3.99	1.01	4.51	PF	4.68	3.89	1.06	NA	NA	NA	NA	NA
04/08/93	365.50	4.63	2.18	1.79	2.34	3.22	3.94	3.98	0.92	4.14	1.34	4.00	1.01	4.52	PF	4.61	3.96	3.99	NA	NA	NA	NA	NA
04/09/93	365.50	4.70	2.26	1.79	2.39	3.25	3.98	4.04	0.95	4.19	1.40	4.08	1.09	4.55	PF	4.66	3.92	3.99	NA	NA	NA	NA	NA
04/10/93	365.50	5.16	2.64	1.93	2.37	3.46	4.18	4.26	0.99	4.24	1.43	4.06	1.12	4.55	PF	5.15	4.17	4.45	NA	NA	NA	NA	NA
04/11/93	365.50	4.34	2.84	2.03	2.07	3.59	4.24	4.17	0.95	4.19	1.35	3.97	1.05	4.45	0.84	5.25	4.24	4.72	NA	NA	NA	NA	NA
04/12/93	365.50	6.15	3.65	2.00	2.10	3.70	4.24	4.20	0.93	4.10	1.24	3.87	0.98	4.33	0.87	5.80	4.55	5.30	NA	NA	NA	NA	NA
04/13/93	365.50	6.05	3.58	2.18	1.97	3.89	4.38	4.27	0.94	4.13	1.16	3.79	0.85	4.27	0.83	5.92	4.54	5.48	NA	NA	NA	NA	NA
04/14/93	365.50	3.84	2.55	1.91	1.89	3.39	4.01	3.93	0.91	3.94	1.11	3.70	0.81	4.23	0.81	5.03	5.04	3.96	NA	NA	NA	NA	NA
04/15/93	365.50	4.81	2.31	1.74	1.88	3.23	3.89	3.86	0.95	3.92	1.14	3.73	0.83	4.24	0.82	4.80	3.83	4.29	NA	NA	NA	NA	NA
04/16/93	365.50	4.75	2.26	1.66	1.89	3.16	3.81	3.84	0.95	3.92	1.16	3.74	0.84	4.24	0.85	4.72	3.80	4.18	NA	NA	NA	NA	NA
04/17/93	365.50	4.90	2.35	1.70	1.85	3.20	3.84	3.87	0.95	3.92	1.16	3.76	0.85	4.23	0.84	4.84	3.89	4.33	NA	NA	NA	NA	NA
04/18/93	365.50	4.88	2.39	1.68	1.74	3.20	3.80	3.85	0.90	3.90	1.17	3.71	0.85	4.21	1.15	4.84	3.85	4.33	NA	NA	NA	NA	NA
04/19/93	365.50	4.79	2.28	1.64	1.75	3.16	3.77	4.83	0.94	3.89	1.15	3.71	0.83	4.21	0.91	4.76	3.80	4.25	NA	NA	NA	NA	NA
04/20/93	365.50	4.73	2.21	1.60	1.82	3.11	3.73	3.82	0.98	3.90	1.18	3.74	0.85	4.23	0.92	4.69	3.78	4.10	NA	NA	NA	NA	NA
04/21/93	365.50	4.65	2.16	1.60	1.85	3.10	3.74	3.82	0.98	3.92	1.20	3.78	0.87	4.25	0.91	4.63	3.73	4.01	NA	NA	NA	NA	NA
04/22/93	365.50	4.65	2.17	1.60	1.89	3.10	3.75	3.85	0.98	3.97	1.23	3.81	0.89	4.30	0.93	4.62	3.76	4.00	NA	NA	NA	NA	NA
04/23/93	365.50	4.72	2.30	1.68	1.86	3.17	3.87	3.90	0.97	4.01	1.27	3.85	0.90	4.32	0.91	4.70	3.83	4.16	NA	NA	NA	NA	NA
04/24/93	365.50	4.76	2.28	1.77	1.92	3.21	3.94	3.96	0.99	4.06	1.32	3.91	0.94	4.40	0.92	4.76	4.88	4.28	NA	NA	NA	NA	NA
04/25/93	365.50	4.88	2.41	1.79	2.05	3.30	4.04	4.04	1.06	4.10	1.40	4.00	1.07	4.45	1.00	4.85	3.97	4.37	NA	NA	NA	NA	NA
04/26/93	365.50	4.93	2.49	1.88	2.19	3.35	4.12	4.09	1.08	4.21	1.44	4.04	1.11	4.50	1.01	4.91	4.02	4.42	NA	NA	NA	NA	NA
04/27/93	365.50	5.09	2.63	1.95	2.01	3.50	4.28	4.21	1.03	4.31	1.43	4.12	1.06	4.57	0.92	5.07	4.16	4.64	NA	NA	NA	NA	NA
04/28/93	365.50	5.23	2.71	2.01	2.03	3.58	4.33	4.24	1.06	4.30	1.46	4.11	1.10	4.56	0.96	5.20	4.22	4.75	NA	NA	NA	NA	NA
04/29/93	365.50	5.30	2.82	2.05	2.09	3.61	4.39	4.27	1.04	4.34	1.44	4.12	1.08	4.55	0.94	5.27	5.26	5.82	NA	NA	NA	NA	NA
04/30/93	365.50	5.34	2.84	2.08	2.05	3.64	4.44	4.32	1.08	4.37	1.50	4.15	1.13	4.59	1.01	5.34	4.31	4.88	NA	NA	NA	NA	NA
05/01/93	365.50	5.83	3.33	2.22	2.26	3.85	4.65	4.52	1.63	4.56	1.97	4.31	1.63	4.71	1.57	5.69	4.60	5.30	NA	NA	NA	NA	NA
05/02/93	365.50	4.82	3.35	2.32	2.29	3.94	4.71	4.53	1.50	4.51	1.85	4.26	1.52	4.66	1.44	5.76	4.60	5.34	NA	NA	NA	NA	NA
05/28/93	365.50	6.40	3.90	2.81	2.75	4.45	5.25	4.98	1.66	4.94	2.06	4.63	1.84	5.08	1.62	6.32	5.09	5.85	NA	NA	NA	NA	NA
07/01/93	365.50	6.37	3.89	2.98	2.90	4.57	5.33	5.13	1.68	5.12	2.08	4.83	1.77	5.34	1.62	6.35	5.20	5.78	NA	NA	NA	NA	NA
07/31/93	365.50	6.26	3.77	3.02	2.95	4.56	5.33	5.12	1.59	5.14	1.98	4.88	1.62	5.40	1.52	6.33	5.18	5.66	NA	NA	NA	NA	NA
09/01/93	380.19	6.30	3.81	3.09	3.03	4.61	5.36	5.18	1.62	5.20	2.01	4.94	1.71	5.49	1.56	6.27	5.23	5.66	NA	NA	NA	NA	NA
09/29/93	380.18	6.36	3.88	3.15	2.77	4.77	5.36	5.20	1.66	5.20	2.09	4.91	1.82	5.45	1.64	6.37	5.28	5.70	NA	NA	NA	NA	NA
11/02/93	383.13	6.24	3.75	3.07	2.72	4.55	5.26	4.99	1.01	5.00	1.53	4.70	1.22	5.25	0.98	6.21	5.12	5.55	NA	NA	NA	NA	NA
12/01/93	384.10	5.61	3.12	2.57	2.45	4.01	4.77	4.50	1.01	4.60	1.50	4.48	1.20	5.02	1.00	5.60	4.62	5.08	NA	NA	NA	NA	NA
12/29/93	383.50	6.40	3.90	2.80	2.62	4.42	5.20	4.78	1.07	4.80	1.54	4.54	1.25	5.02	1.05	6.25	5.02	5.70	NA	NA	NA	NA	NA
02/01/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
03/01/94	383.10	NA	NA	3.09	2.88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	5.36	PI	2.21	2.19	3.72	4.35	4.21	PI	4.30	1.62	4.11	1.33	4.78	PI	5.27	4.30	4.99	13.72	9.51	13.89	11.04	PI
04/07/94	389.90	5.23	2.76	1.99	1.76	3.52	4.03	4.01	1.00	4.05	1.41	3.87	1.16	4.38	PI	5.16	4.12	4.79	13.33	9.28	13.62	10.91	1.98
04/08/94	389.80	4.75	2.35	1.84	1.78	3.28	3.83	3.86	1.00	3.99	1.42	3.86	1.15	4.37	PI	4.78	3.85	4.33	13.31	8.67	13.53	11.13	1.90
04/09/94	389.09	4.79	2.33	1.80	1.80	3.28	3.84	3.87	9.70	4.00	1.40	3.90	1.12	4.40	PI	4.75	3.90	4.30	13.42	9.32	13.60	11.00	1.86
04/10/94	385.70	4.88	2.37	1.84	1.84	3.33	3.95	3.97	1.10	4.10	1.51	3.97	1.26	4.44	PI	4.84	3.97	4.43	13.68	10.95	13.55	9.33	1.98
04/11/94	387.39	4.92	2.43	1.91	1.90	3.36	3.98	3.95	0.92	4.06	1.43	3.95	1.16	4.42	1.15	4.90	3.98	4.55	13.45	9.10	13.65	11.05	1.93
04/12/94	386.35	5.00	2.50	1.91	1.93	3.41	4.02	3.99	0.99	4.10	1.46	3.95	1.20	4.44	1.03	4.95	4.00	4.57	13.50	8.89	13.68	11.02	1.98
04/13/94	385.10	5.00	2.50	1.92	1.92	3.45	4.06	4.00	1.06	4.15	1.50	4.00	1.25	4.45	1.12	4.95	4.05	4.63	13.60	8.75	13.73	10.95	2.04
04/14/94	386.00	4.88	2.42	1.90	1.80	3.39	3.95	3.90	1.00	4.00	1.48	3.87	1.20	4.35	1.03	4.85	3.92	4.60	13.40	9.11	13.63	10.93	1.92
04/15/94	385.22	4.90	2.35	1.85	1.75	3.30	3.90	3.90	1.05	4.04	1.50	3.90	1.25	4.40	1.10	4.80	3.90	4.41	13.50	6.20	13.60	11.00	2.00
04/16/94	385.04	4.91	2.40	1.83	1.76	3.33	3.93	3.90	1.01	4.02	1.46	3.87	1.20	4.36	1.04	4.85	3.93	4.51	13.06	10.89	13.42	5.64	2.00
04/17/94	385.21	4.91	2.43	1.86	1.74	3.33	3.90	3.89	0.99	3.99	1.44	3.86	1.19	4.34	1.02	4.92	3.92	4.52	13.39	10.97	13.59	3.86	2.00
04/18/94	384.47	5.00	2.50	1.87	1.78	3.37	3.97	3.95	1.06	4.06	1.50	3.92	1.24	4.38	1.09	4.91	3.99	4.59	13.47	4.78	13.65	10.98	2.08
04/19/94	383.12	5.48	2.98	2.05	1.94	3.66	4.29	4.14	1.11	4.21	1.56	3.98	1.29	4.46	1.12	5.38	4.26	5.08	13.57	7.58	13.83	11.00	2.18
05/02/94	383.51	5.97	3.48	2.53	2.22	4.13	4.80	4.54	1.41	4.56	1.84	4.30	1.57	4.77	1.43	5.90	4.68	5.55	13.34	6.47	14.20	11.30	2.46
05/24/94	382.56	6.12	3.63	2.63	2.39	4.25	4.92	4.62	1.46	4.62	1.90	4.33	1.64	4.78	1.49	6.05	4.79	6.67	13.97	9.26	14.26	11.23	2.64
06/27/94	380.05	6.37	3.89	2.96	2.74	4.55	5.22	4.93	1.65	4.98	2.02	4.72	1.81	5.20	1.62	6.31	5.10	5.79	14.38	5.24	14.61	11.47	2.95
08/01/94	379.88	6.35	3.86	3.30	2.78	4.60	5.26	5.01	1.59	5.03	2.03	4.77	1.80	5.25	1.62	6.28	5.13	5.63	14.46	9.48	14.66	11.50	4.59
09/01/94	379.80	6.40	3.91	3.14	2.90	4.68	5.32	5.06	1.62	5.10	2.06	4.80	1.85	5.30	1.65	6.35	5.20	5.76	14.50	9.46	14.72	11.51	3.92
10/03/94	382.18	6.33	3.84	3.05	2.68	4.58	5.22	4.90	1.00	4.95	1.56	4.64	1.36	5.16	1.05	6.27	5.01	5.60	14.37	9.50	14.56	11.15	2.65
10/28/94	382.11	6.32	3.85	3.01	2.80	4.60	5.30	4.95	1.02	5.00	1.60	4.72	1.38	5.27	1.07	6.30	5.15	5.65	14.44	9.71	14.62	11.05	2.10
12/02/94	384.05	6.40	3.88	3.07	3.77	4.59	5.27	4.79	1.77	4.84	1.88	4.86	1.61	5.10	1.27	6.30	5.10	5.72	14.42	9.08	14.62	11.43	2.11
03/02/95	382.78	PI	PI	2.90	2.80	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
03/28/95	383.84	5.75	3.27	2.44	2.45	4.00	4.68	4.47	0.89	4.49	1.40	4.29	1.15	4.79	0.89	5.63	4.57	5.22	13.90	9.76	14.15	10.82	1.97
05/01/95	381.76	6.44	3.93	2.75	2.70	4.51	5.19	5.07	1.37	5.09	1.91	4.80	1.63	5.20	1.55	6.18	5.29	5.80	14.30	10.66	14.63	10.95	2.93
05/26/95	380.96	6.40	3.90	2.90	2.78	4.51	5.20	4.95	1.55	5.00	2.00	4.71	1.80	5.16	1.60	6.20	5.13	5.76	14.35	10.97	14.65	11.41	2.90
06/27/95	379.60	6.40	3.91	3.03	2.97	4.65	5.33	5.10	1.70	5.15	2.13	4.90	1.91	5.38	1.72	6.30	5.23	5.80	14.51	10.38	14.80	11.57	3.26
07/26/95	379.21	6.36	3.87	3.15	2.98	4.68	5.35	5.05	1.56	5.21	2.02	4.97	1.81	5.47	1.60	6.26	5.25	5.69	14.59	10.41	14.85	11.25	3.06
08/31/95	380.02	6.25	3.78	3.17	2.98	4.70	5.38	5.16	1.65	5.25	2.10	4.96	1.89	5.45	1.70	6.21	5.25	5.74	14.88	14.46	14.61	11.00	3.34
09/29/95	380.16	6.30	3.81	3.20	2.96	4.69	5.37	5.16	1.45	5.25	2.04	5.00	1.84	5.53	1.58	6.15	5.37	5.74	14.64	10.58	14.90	11.55	3.22
10/29/95	389.70	5.05	2.59	2.37	2.06	3.72	4.20	4.24	0.96	4.33	1.35	4.18	1.11	4.73	1.00	5.02	4.23	4.52	13.65	3.90	13.90	10.97	2.56
10/30/95	388.53	4.95	2.40	2.24	2.10	4.12	3.59	4.18	0.91	4.33	1.33	4.20	1.11	4.85	0.98	5.90	4.14	4.25	13.75	5.85	13.90	11.01	2.64
10/31/95	385.80	5.03	2.50	2.25	2.22	3.64	3.34	4.30	0.94	4.45	1.42	4.31	1.18	4.92	0.96	4.99	4.26	4.43	13.90	7.97	14.02	11.96	2.62
11/01/95	386.91	5.15	2.64	2.32	2.26	3.72	4.30	4.31	0.89	4.42	1.35	4.77	1.14	4.78	0.91	5.08	4.31	4.78	13.85	9.46	14.00	11.85	2.69
11/02/95	383.17	5.23	2.75	2.36	2.98	3.80	4.45	4.37	1.04	4.50	1.43	4.32	1.25	4.81	1.00	5.20	4.37	4.71	14.00	9.03	14.10	10.93	2.50
11/03/95	385.81	4.98	2.50	2.25	2.00	3.61	4.17	4.20	0.90	4.32	1.35	4.20	1.15	4.70	0.93	4.96	4.20	4.42	13.72	6.00	13.90	10.82	2.40
11/04/95	386.35	5.04	3.54	2.24	2.04	3.65	3.19	4.23	0.86	4.35	1.32	4.13	1.09	4.68	0.87	5.04	4.23	4.51	13.73	7.11	13.98	10.88	2.31
11/05/95	385.03	5.27	2.83	2.28	2.14	3.78	4.30	4.25	0.89	4.39	1.34	4.14	1.12	4.69	0.92	5.20	4.34	4.69	13.80	8.16	14.00	10.91	2.44
11/06/95	384.85	5.50	3.03	2.38	2.20	3.86	4.55	4.37	0.94	4.47	1.38	4.24	1.15	4.74	0.93	5.39	4.48	4.90	13.90	9.44	14.10	8.90	2.52
11/07/95	384.53	5.65	3.18	2.44	2.28	3.95	4.55	4.44	0.91	4.52	1.38	4.28	1.18	4.78	0.94	5.53	4.56	5.14	14.91	9.64	14.81	10.30	2.59
11/13/95	388.50	5.12	2.63	2.32	1.98	3.73	4.26	4.22	0.90	4.30	1.31	4.10	1.10	4.60	0.95	5.10	4.24	4.66	13.61	6.96	13.90	10.91	2.52
11/14/95	384.91	5.10	2.60	2.21	2.03	3.62	4.25	4.22	0.93	5.34	1.38	4.20	1.15	4.65	0.95	5.05	5.05	4.55	13.85	8.50	13.95	11.85	2.50
11/15/95	389.71	5.18	2.71	2.30	1.82	3.73	4.27	4.20	0.97	4.26	1.33	4.04	1.09	4.52	0.96	5.14	4.25	4.73	13.60	4.20	13.70	10.71	2.54
11/16/95	390.03	5.05	2.49	2.10	1.82	3.54	4.06	4.09	0.91	4.18	1.32	3.98	1.08	4.49	0.91	4.99	4.10	4.45	13.54	6.82	13.82	10.89	2.45
11/17/95	389.65	5.00	2.45	2.07	1.87	3.49	4.13	4.08	0.88	4.18	1.29	3.99	1.06	4.48	0.90	4.95	4.10	4.37	13.55	7.98	13.75	10.30	2.45
11/18/95	386.62	5.00	2.46	2.08	2.01	3.54	4.14	4.26	0.89	4.27	1.34	4.10	1.12	4.57	0.89	4.95	4.15	4.47	13.71	8.98	13.87	10.85	2.46
11/19/95	384.58	5.22	2.72	2.17	2.10	3.70	4.32	4.25	0.96	4.35	1.40	4.15	1.18	4.61	0.90	5.17	4.28	4.81	14.90	9.52	14.78	10.25	2.53
11/20/95	383.30	5.38	2.89	2.28	2.14	3.79	4.48	4.31	0.98	4.40	2.42	4.17	1.18	4.64	0.93	5.31	4.34	4.93	13.89	8.54	14.08	10.82	2.57
11/21/95	383.60	5.34	2.85	2.24	2.15	3.76	4.42	4.33	0.96	4.44	1.44	4.19	1.22	4.66	0.98	5.27	4.33	4.87	13.81	8.86	14.03	10.86	2.67
11/22/95	385.66	5.65	3.09	2.34	2.14	3.86	4.51	4.33	0.99	4.38	1.41	4.14	1.19	4.61	0.96	5.48	4.43	5.05	13.80	8.63	14.05	10.30	2.66
12/27/95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
01/22/96	389.05	5.16	2.64	2.17	2.43	3.62	4.29	4.20	0.93	4.32	1.36	4.16	1.14	4.67	0.92	5.08	4.22	4.64	13.67	10.41	13.90	10.93	PF
01/23/96	388.20	5.09	2.58	2.12	2.42	3.60	4.30	4.20	0.95	4.32	1.38	4.19	1.16	4.67	0.95	5.04	4.21	4.63	13.74	10.34	13.90	10.90	2.45
01/24/96	384.67	5.19	2.71	2.12	2.44	3.63	4.37	4.22	1.09	4.36	1.48	4.22	1.25	4.70	0.96	5.11	4.21	4.72	13.86	10.08	13.99	10.91	2.40
01/25/96	390.00	5.18	2.67	2.28	2.30	3.70	4.35	4.23	0.85	4.30	1.32	4.12	1.10	4.61	0.87	5.13	4.25	4.71	13.65	7.28	13.92	11.02	2.37
01/26/96	388.85	4.90	2.28	2.05	2.25	3.48	4.12	4.10	0.90	4.20	1.32	4.10	1.12	4.62	0.90	4.85	4.05	4.41	13.62	6.55	13.80	11.06	2.30
01/27/96	386.67	4.99	2.46	2.01	2.33	3.48	4.16	4.15	0.98	4.29	1.42	4.15	1.20	4.62	0.99	4.93	4.13	4.48	13.87	10.87			2.33
01/28/96	391.02	5.16	2.80	2.01	2.00	3.52	4.11	4.05	0.90	4.10	1.30	3.92	1.10	4.43	0.88	5.08	4.12	4.63	13.44	5.56	13.70	10.94	2.21
01/29/96	393.59	5.11	2.67	1.97	1.92	3.46	3.99	3.98	0.88	4.03	1.26	3.86	1.04	4.36	0.88	5.03	4.06	4.57	13.60	6.37	13.67	10.98	2.18
01/30/96	393.86	4.87	2.41	1.81	1.88	3.29	3.85	3.86	0.85	3.95	1.21	3.80	0.98	4.29	0.86	4.81	3.86	4.24	13.29	7.40	13.55	10.76	2.19
01/31/96	391.20	4.93	2.43	1.82	1.95	3.31	3.91	3.94	0.91	4.08	1.28	3.91	1.04	4.38	0.90	4.85	3.95	4.16	13.47	8.54	13.67	10.87	2.28
02/01/96	386.03	5.02	2.55	1.92	2.16	3.46	4.16	4.15	0.98	4.29	1.42	4.11	1.20	4.55	0.98	4.95	4.11	4.40	13.78	9.58	13.87	10.97	2.42
02/02/96	383.94	5.28	2.79	2.09	2.28	3.66	4.40	4.28	0.98	4.29	1.50	4.18	1.28	4.62	0.97	5.21	4.29	4.85	13.83	9.87	14.00	10.95	2.43
02/03/96	383.50	5.56	3.10	2.20	2.32	3.80	4.51	4.32	1.00	4.40	1.52	4.16	1.30	4.61	1.00	5.47	4.42	5.10	PI	PI	PI	PI	2.50
02/04/96	384.10	5.05	3.60	2.34	2.40	4.05	4.17	4.49	PI	4.48	1.50	4.20	1.29	4.63	0.94	5.90	4.67	5.58	PI	PI	PI	PI	2.52

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL.	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
02/05/96	384.56	5.80	3.33	2.39	2.43	4.00	4.70	4.48	0.93	4.50	1.49	4.24	1.27	0.86	4.67	5.68	4.60	5.35	PI	PI	PI	PI	2.58
02/06/96	383.90	6.24	3.76	2.49	2.51	4.17	4.89	4.59	PI	4.59	1.55	4.31	1.32	4.72	PI	6.07	4.81	5.70	PI	PI	PI	PI	2.72
02/08/96	384.60	6.12	3.64	2.56	2.58	4.21	4.94	4.60	PI	4.60	1.46	4.28	1.18	4.47	PI	5.97	4.77	5.62	PI	PI	PI	PI	2.71
02/28/96	383.60	5.38	2.84	2.13	2.51	3.68	4.43	4.26	0.81	4.34	1.51	4.14	1.29	4.61	0.85	5.26	4.31	4.84	13.75	10.15	13.97	10.90	2.74
03/28/96	384.30	5.80	3.30	2.40	2.50	4.00	4.72	4.48	0.97	4.50	1.45	4.29	1.25	4.75	0.87	5.70	4.60	5.22	13.88	10.38	14.15	10.95	2.80
04/17/96	395.00	6.40	3.95	2.20	1.65	3.98	4.30	4.22	4.41	4.10	1.16	3.67	0.92	4.41	0.98	6.12	4.62	5.69	13.10	4.63	13.75	10.24	2.73
04/18/96	400.10	6.36	3.90	2.15	1.60	3.95	4.26	4.20	4.39	4.00	1.15	3.65	0.90	4.12	0.96	6.10	4.60	5.67	13.04	4.61	13.72	10.20	2.70
04/20/96	401.40	4.77	2.17	1.57	1.63	3.08	3.61	3.67	0.85	3.74	1.04	3.58	0.76	4.06	0.86	4.67	3.68	4.01	13.08	8.80	13.10	10.72	2.16
04/22/96	397.10	4.87	2.28	1.60	1.83	3.19	3.76	3.84	0.91	3.94	1.20	3.77	0.94	4.20	0.91	4.76	3.83	4.09	13.80	10.50	13.02	8.99	2.27
04/23/96	395.60	4.82	2.33	1.66	1.79	3.21	3.82	3.82	0.89	3.93	1.18	3.77	0.92	4.24	0.80	4.74	3.78	4.06	13.56	10.79	13.43	8.21	2.08
04/24/96	395.60	4.91	2.46	1.72	1.71	3.26	3.83	3.90	0.81	4.00	1.23	3.89	0.91	4.30	0.80	4.82	3.87	4.12	13.63	10.76	13.51	6.78	2.10
04/25/96	389.90	4.98	2.41	1.89	1.91	3.43	4.09	4.07	1.92	4.20	1.39	4.05	1.18	4.47	0.92	4.96	4.08	4.30	13.71	7.83	13.95	10.92	2.21
04/26/96	386.40	5.03	2.50	1.89	1.98	3.42	4.17	4.16	0.99	4.30	1.47	4.17	1.28	4.53	0.99	5.00	4.21	4.40	13.76	8.42	13.85	10.84	2.28
04/27/96	386.89	5.17	2.69	1.99	2.02	3.52	4.20	4.12	0.91	4.20	1.38	4.04	1.16	4.49	0.90	5.10	4.13	4.66	13.83	10.93	13.66	8.90	2.18
04/28/96	384.23	5.46	3.00	2.12	2.13	3.65	4.36	4.23	0.96	4.32	1.44	4.14	1.22	4.55	0.93	5.35	4.31	4.92	13.80	9.10	13.98	11.00	2.24
04/29/96	383.50	5.48	2.99	2.15	2.19	3.74	4.45	4.31	0.96	4.39	1.47	4.24	1.26	4.61	0.96	5.39	4.37	5.01	13.93	9.19	14.03	10.92	2.31
04/30/96	384.30	5.49	3.01	2.16	2.06	3.74	4.46	4.27	0.93	4.32	1.43	4.13	1.22	4.54	0.93	5.39	4.35	4.99	8.30	10.80	10.34	13.80	2.26
06/04/96	380.57	6.45	3.96	2.76	2.57	4.45	5.14	4.85	1.56	4.83	1.98	4.50	1.75	4.87	1.58	6.32	5.03	5.85	NA	NA	NA	NA	NA
07/01/96	380.00	6.45	3.96	2.92	2.81	4.56	5.26	4.97	1.59	4.98	2.02	4.69	1.80	5.08	1.60	6.34	5.14	5.83	14.37	10.05	14.66	11.43	3.07
07/29/96	380.29	6.47	3.99	2.99	2.79	4.61	5.29	5.00	1.62	4.98	2.05	4.70	1.83	5.10	1.63	6.35	5.16	5.87	14.40	10.20	14.71	11.50	2.79
08/28/96	380.11	6.38	3.90	3.06	3.00	4.64	5.34	5.13	1.65	5.16	2.09	4.93	1.88	5.36	1.69	6.29	5.24	5.78	14.53	10.51	14.81	11.53	2.78
09/29/96	379.91	6.35	3.86	3.12	2.91	4.66	5.35	5.12	1.65	5.16	2.11	4.93	1.90	5.37	1.67	6.27	5.24	5.75	14.84	11.60	14.56	9.60	2.84
10/21/96	392.44	6.02	3.53	2.72	2.34	4.20	4.76	4.46	0.90	4.39	1.29	4.17	1.06	4.68	0.91	5.91	4.75	5.39	13.53	2.76	14.00	11.01	2.27
10/22/96	401.65	6.05	3.57	2.49	1.83	4.05	4.29	4.29	0.88	4.16	1.11	3.88	0.87	4.40	0.88	5.91	4.63	5.40	13.20	6.48	13.83	10.90	2.20
10/23/96	401.80	4.94	2.44	2.21	1.75	3.54	3.94	3.93	0.83	3.95	1.00	3.75	0.74	4.28	0.85	4.93	3.99	4.29	13.20	11.58	13.53	10.88	1.95
10/24/96	403.17	4.95	2.45	1.98	1.85	3.39	3.85	3.90	0.87	3.99	1.04	3.80	0.79	4.32	0.85	4.89	3.97	4.25	13.30	8.20	13.55	10.85	1.95
10/25/96	401.36	4.97	2.40	1.96	2.00	3.40	3.90	4.00	0.85	4.05	1.11	3.90	0.87	4.40	0.90	4.87	4.00	4.10	13.43	8.85	13.74	10.90	1.97
10/26/96	401.00	4.95	2.41	1.98	2.10	3.44	3.98	4.03	0.87	4.15	1.20	3.99	0.92	4.48	0.88	4.90	4.03	4.15	13.58	8.80	13.76	10.95	1.97
10/27/96	397.60	4.96	2.43	2.01	2.16	3.47	4.04	4.11	0.91	4.22	1.24	4.05	1.00	4.53	0.92	4.92	4.08	4.16	13.69	8.57	13.83	10.90	2.01
10/28/96	393.85	5.04	2.43	2.07	2.23	3.53	4.12	4.31	0.95	4.51	1.33	4.41	1.09	4.95	0.97	4.96	4.19	4.05	13.95	8.30	14.04	10.87	2.10
10/29/96	386.84	5.05	2.50	2.20	2.42	3.65	4.35	4.40	1.01	4.61	1.45	4.47	1.22	4.90	0.97	5.01	4.29	4.25	14.22	8.26	14.23	11.02	2.10
10/30/96	383.80	5.44	2.96	2.41	2.54	3.92	4.68	4.51	0.94	4.69	1.51	4.50	1.29	4.94	0.95	5.37	4.58	4.84	14.26	8.24	14.34	10.86	2.21
10/31/96	383.53	5.65	3.16	2.51	2.55	4.06	4.78	4.60	0.97	4.68	1.51	4.50	1.32	4.92	0.96	5.56	4.65	5.04	14.18	8.29	14.35	10.94	2.30
11/01/96	383.70	6.21	3.74	2.60	2.55	4.22	4.90	4.68	0.99	4.68	1.52	4.42	1.30	4.86	0.99	6.05	4.90	5.50	14.11	8.41	14.41	10.97	2.42
11/02/96	384.50	5.89	3.40	2.36	2.54	4.18	4.87	4.60	0.89	4.69	1.44	4.40	1.23	4.84	0.92	5.80	4.75	5.28	14.20	8.42	14.35	10.95	2.36
11/03/96	383.40	6.26	3.75	2.73	2.60	4.33	5.02	4.76	0.98	4.78	1.52	4.50	1.31	4.90	1.02	6.10	4.98	5.52	14.20	8.55	14.48	10.99	2.52
11/10/96	389.60	4.97	2.49	2.42	2.40	3.80	4.50	4.28	0.88	4.35	1.22	4.15	1.00	4.62	0.80	5.05	4.22	4.65	13.71	5.82	13.98	10.87	2.22
11/11/96	386.60	5.26	2.80	2.28	2.36	3.65	4.38	4.24	0.84	4.38	1.30	4.20	1.10	4.72	0.85	5.20	4.30	4.65	14.80	7.95	PI	PI	2.25
11/12/96	386.10	4.99	2.52	2.18	2.32	3.58	4.28	4.20	0.76	4.32	1.27	4.20	1.04	4.70	0.80	4.97	4.22	4.50	13.77	9.05	13.93	10.89	2.17
11/13/96	383.65	5.28	2.78	2.25	2.38	3.75	4.45	4.33	0.95	4.49	1.43	4.32	1.23	4.79	0.97	5.23	4.39	4.75	13.95	9.27	14.10	10.92	2.32
11/14/96	383.80	5.30	2.81	2.29	2.40	3.75	4.46	4.36	0.90	4.49	1.40	4.33	1.19	4.82	0.93	5.23	4.39	4.79	13.91	9.39	14.09	10.87	2.30
11/15/96	384.22	5.86	3.35	2.40	2.45	4.03	4.71	4.54	0.97	4.58	1.46	4.38	1.27	4.87	0.98	5.72	4.67	5.30	13.95	9.52	14.15	10.95	2.41
11/29/96	383.81	5.98	3.48	2.58	2.52	4.18	4.90	4.62	0.95	4.64	1.46	4.40	1.27	4.85	0.97	5.88	4.77	5.38	14.10	8.50	14.43	10.94	2.50
12/31/96	385.42	5.35	2.86	2.08	1.95	3.64	4.32	4.21	0.90	4.26	1.37	4.07	1.16	4.51	0.91	5.27	4.27	4.79	PI	PI	PI	PI	2.24
03/31/97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/21/97	398.04	5.01	2.52	1.98	1.59	3.45	3.99	3.88	0.88	3.85	1.11	3.73	0.85	4.11	0.88	4.97	4.95	4.50	13.10	7.00	13.55	10.80	2.40
04/22/97	398.20	4.80	2.33	1.65	1.60	3.15	3.70	3.72	0.85	3.79	1.08	3.60	1.83	4.09	0.87	3.72	3.75	4.22	13.01	7.80	13.40	10.70	2.30
04/23/97	397.03	4.82	2.31	1.62	1.68	3.26	3.85	3.78	0.87	3.84	1.13	3.68	0.88	4.15	0.88	4.74	3.79	4.23	13.20	8.47	13.52	10.72	2.35
04/24/97	394.28	4.70	2.22	1.63	1.80	3.15	3.80	3.82	0.83	3.94	1.17	3.78	0.92	4.25	0.84	4.65	3.75	4.15	13.33	8.59	13.52	10.82	2.32
04/25/97	392.17	4.80	2.31	1.70	1.94	3.21	3.90	3.92	0.85	4.03	1.24	3.90	1.00	4.34	0.85	4.72	3.85	4.23	13.65	10.87	13.50	8.60	2.40
04/26/97	385.98	5.02	2.56	1.82	2.08	3.40	4.17	4.12	0.96	4.28	1.40	4.11	1.15	4.50	0.93	4.97	4.07	4.45	13.85	8.70	13.90	10.90	2.52
04/27/97	383.05	5.47	2.96	2.09	2.22	3.33	4.50	4.32	0.90	4.37	1.46	4.35	1.26	4.58	0.89	5.37	4.34	4.83	13.83	8.80	14.07	10.90	2.66
04/28/97	383.35	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/29/97	385.02	5.25	2.78	2.10	1.88	3.64	4.32	4.20	0.87	4.25	1.38	4.05	1.18	4.49	0.90	5.20	4.22	4.66	13.92	10.87	13.65	5.86	2.61
04/30/97	383.52	5.36	2.85	2.09	1.94	3.76	4.36	4.25	0.99	4.32	1.48	4.12	1.21	4.52	1.02	5.28	4.30	4.75	13.72	7.87	13.98	10.85	2.70

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible

PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
01/31/92	382.70	363.8	363.6	376.1	375.9	370.7	367.8	369.1	381.5	369.5	380.1	369.8	380.2	368.6	381.9	364.2	368.3	365.2	NA	NA	NA	NA	NA
03/03/92	382.70	364.0	363.8	375.9	375.7	370.7	367.9	369.1	381.9	369.4	380.1	369.7	380.2	368.4	381.9	364.5	368.2	381.1	NA	NA	NA	NA	NA
03/12/92	388.96	366.9	366.8	377.4	376.8	372.6	370.0	370.7	381.1	370.9	380.6	370.7	380.4	369.3	378.7	367.1	370.2	368.7	NA	NA	NA	NA	NA
03/13/92	388.73	366.9	366.7	377.7	376.7	372.8	370.2	370.7	381.7	370.8	380.5	370.7	380.7	369.4	381.8	367.1	370.2	368.6	NA	NA	NA	NA	NA
03/14/92	386.90	366.9	366.7	377.8	376.7	372.9	370.2	370.8	381.6	370.8	380.3	370.6	380.6	369.4	381.9	367.3	370.4	368.6	NA	NA	NA	NA	NA
03/15/92	384.85	365.8	365.6	377.5	376.4	372.4	369.6	370.0	381.6	370.3	380.2	370.3	380.4	369.1	381.9	366.4	369.7	367.8	NA	NA	NA	NA	NA
03/16/92	385.12	365.8	365.6	377.2	376.3	372.1	369.0	370.1	381.7	370.2	380.3	370.2	380.4	368.7	381.9	366.1	369.5	367.5	NA	NA	NA	NA	NA
03/17/92	383.50	365.8	365.5	377.1	376.2	372.0	369.1	370.0	381.6	370.1	380.2	370.2	380.3	368.9	381.9	366.2	369.4	367.5	NA	NA	NA	NA	NA
03/18/92	382.48	364.6	364.3	376.6	376.0	371.3	368.5	369.5	381.5	369.7	379.9	369.9	380.1	368.7	381.9	365.0	368.7	366.9	NA	NA	NA	NA	NA
03/19/92	382.80	363.9	363.6	376.1	375.9	370.8	368.0	369.2	381.4	369.6	380.1	369.8	380.1	368.6	381.9	364.3	368.3	365.9	NA	NA	NA	NA	NA
03/20/92	382.60	363.7	363.5	375.7	375.9	370.7	367.9	369.1	381.4	369.5	379.9	369.7	380.1	368.6	381.9	364.2	368.2	365.9	NA	NA	NA	NA	NA
04/03/92	384.20	365.3	365.4	376.9	376.7	371.8	369.1	370.0	381.7	370.3	PI	370.4	380.5	369.2	PI	365.6	369.3	367.3	NA	NA	NA	NA	NA
04/30/92	380.98	365.7	365.4	377.1	377.4	371.9	369.2	369.7	379.4	369.8	379.0	370.2	379.2	368.9	379.7	365.9	369.2	367.2	NA	NA	NA	NA	NA
06/02/92	384.96	366.3	366.5	376.6	377.8	371.7	369.4	369.6	379.8	369.9	379.0	370.2	379.0	368.6	380.0	366.1	369.3	367.2	NA	NA	NA	NA	NA
07/01/92	380.15	363.7	363.5	375.6	375.9	370.3	367.7	368.5	379.3	368.8	378.6	369.1	378.7	367.8	379.7	364.1	367.8	365.2	NA	NA	NA	NA	NA
08/04/92	380.12	363.8	363.6	375.4	376.0	370.2	367.7	368.3	379.4	368.6	378.6	368.9	378.7	367.7	379.6	364.1	367.6	365.2	NA	NA	NA	NA	NA
09/01/92	380.00	363.8	363.6	375.3	375.8	370.2	367.6	368.2	379.4	368.5	378.5	368.8	378.5	367.4	379.6	364.0	367.5	365.4	NA	NA	NA	NA	NA
09/28/92	380.57	364.7	364.5	375.7	376.1	370.7	368.1	368.6	380.0	368.8	378.9	368.9	379.0	367.6	380.0	364.9	368.1	366.2	NA	NA	NA	NA	NA
10/30/92	382.12	363.9	363.6	375.3	375.8	370.1	367.6	368.2	381.2	368.4	380.1	368.6	380.2	367.0	381.4	364.1	367.7	365.7	NA	NA	NA	NA	NA
11/30/92	384.00	366.3	366.1	377.0	377.2	372.0	369.7	370.0	381.7	370.1	380.3	370.1	380.5	368.8	381.5	366.8	369.5	367.6	NA	NA	NA	NA	NA
12/31/92	384.00	365.0	364.8	376.2	376.1	371.2	368.6	369.4	382.0	369.6	380.6	369.8	380.9	368.4	381.9	365.4	368.8	366.4	NA	NA	NA	NA	NA
01/29/93	384.00	364.3	364.1	376.6	376.2	371.3	368.6	369.3	381.9	369.6	380.4	369.8	380.8	368.4	PF	365.0	368.5	366.1	NA	NA	NA	NA	NA
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA	NA	NA
03/31/93	393.50	367.2	366.9	377.8	377.2	372.7	371.0	371.1	381.9	371.3	380.9	371.3	381.0	369.8	382.1	367.4	370.7	368.4	NA	NA	NA	NA	NA
04/01/93	398.30	364.6	364.4	377.4	377.8	371.9	370.1	370.6	381.9	371.3	381.2	371.7	381.4	370.2	382.0	365.1	369.4	365.9	NA	NA	NA	NA	NA
04/02/93	402.50	366.9	366.6	377.8	378.0	372.8	370.7	371.3	PF	371.8	381.5	372.1	381.8	370.5	PF	366.9	370.7	367.7	NA	NA	NA	NA	NA
04/03/93	402.90	375.4	358.8	378.4	378.0	373.5	371.2	371.6	PF	371.9	381.5	372.1	381.9	370.6	PF	367.2	371.0	368.2	NA	NA	NA	NA	NA
04/04/93	402.40	368.0	367.7	378.8	377.9	373.9	371.6	371.8	PF	371.7	381.4	372.0	381.7	370.5	PF	368.2	371.4	369.0	NA	NA	NA	NA	NA
04/05/93	401.20	368.9	368.7	379.1	377.8	374.2	372.0	371.7	PF	371.7	381.3	371.4	381.6	369.9	PF	369.1	371.7	370.2	NA	NA	NA	NA	NA
04/06/93	400.10	369.0	368.8	379.1	377.7	374.3	372.0	371.8	PF	371.7	381.3	371.5	381.5	371.3	PF	369.1	371.7	370.2	NA	NA	NA	NA	NA
04/07/93	398.00	369.3	369.0	379.3	377.6	374.5	372.1	371.9	PF	371.8	381.0	371.5	381.3	370.1	PF	369.4	371.9	380.6	NA	NA	NA	NA	NA
04/08/93	365.50	369.5	369.1	379.2	377.4	374.5	372.2	371.9	382.0	371.7	380.9	371.5	381.3	370.1	PF	369.7	371.7	371.0	NA	NA	NA	NA	NA
04/09/93	365.50	369.3	368.9	379.2	377.3	374.4	372.0	371.7	381.9	371.6	380.7	371.2	381.0	370.0	PF	369.5	371.8	371.0	NA	NA	NA	NA	NA
04/10/93	365.50	367.8	367.6	378.8	377.3	373.7	371.4	371.0	381.8	371.4	380.6	371.3	380.9	370.0	PF	367.9	371.0	369.5	NA	NA	NA	NA	NA
04/11/93	365.50	370.5	367.0	378.4	378.3	373.3	371.2	371.3	381.9	371.6	380.9	371.6	381.2	370.3	382.1	367.6	370.8	368.6	NA	NA	NA	NA	NA
04/12/93	365.50	364.5	364.3	378.5	378.2	373.0	371.2	371.2	381.9	371.8	381.2	371.9	381.4	370.7	382.0	365.8	369.8	366.7	NA	NA	NA	NA	NA
04/13/93	365.50	364.8	364.6	377.9	378.6	372.3	370.7	371.0	381.9	371.7	381.5	372.2	381.8	370.9	382.2	365.4	369.8	366.1	NA	NA	NA	NA	NA
04/14/93	365.50	372.1	367.9	378.8	378.9	374.0	371.9	372.1	382.0	372.4	381.7	372.5	381.9	371.0	382.2	368.3	368.2	371.1	NA	NA	NA	NA	NA
04/15/93	365.50	368.9	368.7	379.4	378.9	374.5	372.3	372.3	381.9	372.4	381.6	372.4	381.9	371.0	382.2	369.1	372.1	370.0	NA	NA	NA	NA	NA
04/16/93	365.50	369.1	368.9	379.7	378.9	374.7	372.6	372.4	381.9	372.4	381.5	372.3	381.8	371.0	382.1	369.3	372.2	370.4	NA	NA	NA	NA	NA
04/17/93	365.50	368.6	368.6	379.5	379.0	374.6	372.5	372.3	381.9	372.4	381.5	372.3	381.8	371.0	382.1	368.9	371.9	369.9	NA	NA	NA	NA	NA
04/18/93	365.50	368.7	368.5	379.6	379.4	374.6	372.6	372.4	382.0	372.5	381.5	372.4	381.8	371.1	381.1	368.9	372.1	369.9	NA	NA	NA	NA	NA
04/19/93	365.50	369.0	368.8	379.7	379.4	374.7	372.7	369.2	381.9	372.5	381.5	372.4	381.9	371.1	381.9	369.2	372.2	370.2	NA	NA	NA	NA	NA
04/20/93	365.50	369.2	369.0	379.9	379.1	374.9	372.9	372.5	381.8	372.5	381.4	372.3	381.8	371.0	381.9	369.4	372.3	370.6	NA	NA	NA	NA	NA
04/21/93	365.50	369.4	369.2	379.9	379.0	374.9	372.8	372.5	381.8	372.4	381.4	372.2	381.7	371.0	381.9	369.6	372.5	370.9	NA	NA	NA	NA	NA
04/22/93	365.50	369.4	369.2	379.9	378.9	374.9	372.8	372.4	381.8	372.3	381.3	372.1	381.7	370.8	381.8	369.6	372.4	371.0	NA	NA	NA	NA	NA
04/23/93	365.50	369.2	368.8	379.6	379.0	374.7	372.4	372.2	381.8	372.1	381.1	372.0	381.6	370.7	381.9	369.4	372.1	370.5	NA	NA	NA	NA	NA
04/24/93	365.50	369.1	368.8	379.3	378.8	374.6	372.2	372.0	381.8	372.0	381.0	371.8	381.5	370.5	381.9	369.2	368.7	370.1	NA	NA	NA	NA	NA
04/25/93	365.50	368.7	368.4	379.2	378.4	374.3	371.8	371.7	381.5	371.8	380.7	371.5	381.1	370.3	381.6	368.9	371.7	369.8	NA	NA	NA	NA	NA
04/26/93	365.50	368.5	368.1	378.9	377.9	374.1	371.6	371.6	381.5	371.5	380.6	371.3	381.0	370.1	381.6	368.7	371.5	369.6	NA	NA	NA	NA	NA
04/27/93	365.50	368.0	367.7	378.7	378.5	373.6	371.1	371.2	381.6	371.2	380.6	371.1	381.1	369.9	381.9	368.2	371.1	368.9	NA	NA	NA	NA	NA
04/28/93	365.50	367.5	367.4	378.5	378.4	373.4	370.9	371.1	381.5	371.2	380.5	371.1	381.0	369.9	381.8	367.7	370.9	368.5	NA	NA	NA	NA	NA
04/29/93	365.50	367.3	367.0	378.4	378.2	373.3	370.7	371.0	381.6	371.1	380.6	371.1	381.1	370.0	381.8	367.5	367.4	365.0	NA	NA	NA	NA	NA
04/30/93	365.50	367.2	367.0	378.3	378.4	373.2	370.5	370.8	381.5	371.0	380.4	371.0	380.9	369.8	381.6	367.3	370.6	368.1	NA	NA	NA	NA	NA
05/01/93	365.50	365.6	365.4	377.8	377.7	372.5	369.8	370.2	379.7	370.3	378.8	370.5	379.3	369.4	379.7	366.1	369.6	366.7	NA	NA	NA	NA	NA
05/02/93	365.50	368.9	365.3	377.5	377.6	372.2	369.6	370.1	380.1	370.5	379.2	370.6	379.6	369.6	380.2	365.9	369.6	366.6	NA	NA	NA	NA	NA
05/28/93	365.50	363.7	363.5	375.9	376.1	370.5	367.9	368.7	379.6	369.1	378.5	369.4	378.6	368.2	379.6	364.1	368.0	364.9	NA	NA	NA	NA	NA
07/01/93	365.50	363.8	363.5	375.3	375.6	370.1	367.6	368.2	379.5	368.5	378.5	368.8	378.8	367.4	379.6	364.0	367.6	365.1	NA	NA	NA	NA	NA
07/31/93	365.50	364.2	363.9	375.2	375.4	370.1	367.6	368.2	379.8	368.4	378.8	368.6	379.3	367.2	379.9	364.0	367.7	365.5	NA	NA	NA	NA	NA
09/01/93	380.19	364.0	363.8	375.0	375.2	370.0	367.5	368.0	379.7	368.2	378.7	368.4	379.0	366.9	379.8	364.2	367.5	365.5	NA	NA	NA	NA	NA
09/29/93	380.18	363.8	363.6	374.8	376.0	369.4	367.5	367.9	379.6	368.2	378.4	368.5	378.6	367.0	379.5	363.9	367.4	365.4	NA	NA	NA	NA	NA
11/02/93	383.13	364.2	364.0	375.0	376.2	370.2	367.8	368.6	381.7	368.9	380.3	369.2	380.6	367.7	381.7	364.4	367.9	365.9	NA	NA	NA	NA	NA
12/01/93	384.10	366.3	366.1	376.7	377.1	371.9	369.4	370.2	381.7	370.2	380.4	369.9	380.7	368.4	381.6	366.4	369.5	367.4	NA	NA	NA	NA	NA
12/29/93	383.50	363.7	363.5	375.9	376.5	370.6	368.0	369.3	381.5	369.6	380.2	369.7	380.5	368.4	381.5	364.3	368.2	365.4	NA	NA	NA	NA	NA
02/01/94		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
03/01/94	383.10	NA	NA	375.0	375.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	367.1	PI	377.8	377.9	372.9	370.8	371.2	PI	371.2	380.0	371.1	380.2	369.2	PI	367.5	370.6	367.7	372.9	386.8	372.2	381.7	PI
04/07/94	389.90	367.5	367.2	378.6	379.3	373.6	371.9	371.8	381.7	372.0	380.7	371.9	380.8	370.5	PI	367.9	371.2	368.4	374.2	387.6	373.1	382.1	377.8
04/08/94	389.80	369.1	368.6	379.1	379.3	374.3	372.5	372.3	381.7	372.2	380.6	371.9	380.8	370.6	PI	369.1	372.1	369.9	374.2	389.6	373.4	381.4	378.1
04/09/94	389.09	369.0	368.7	379.2	379.2	374.3	372.5	372.3	353.2	372.2	380.7	371.8	380.9	370.5	PI	369.2	371.9	370.0	373.9	387.4	373.2	381.8	378.2
04/10/94	385.70	368.7	368.5	379.1	379.1	374.2	372.1	372.0	381.4	371.8	380.3	371.6	380.5	370.3	PI	368.9	371.7	369.6	373.0	382.1	373.3	387.3	377.8
04/11/94	387.39	368.6	368.3	378.8	378.9	374.1	372.0	372.0	382.0	372.0	380.6	371.6	380.8	370.4	381.1	368.7	371.6	369.2	373.8	388.1	373.0	381.6	378.0
04/12/94	386.35	368.3	368.1	378.8	378.8	373.9	371.9	371.9	381.8	371.8	380.5	371.6	380.7	370.3	381.5	368.6	371.6	369.1	373.6	388.8	372.9	381.7	377.8
04/13/94	385.10	368.3	368.1	378.8	378.8	373.8	371.8	371.9	381.5	371.7	380.4	371.5	380.5	370.3	381.2	368.6	371.4	368.9	373.3	389.3	372.8	382.0	377.6
04/14/94	386.00	368.7	368.4	378.9	379.2	374.0	372.1	372.2	381.7	372.2	380.4	371.9	380.7	370.6	381.5	368.9	371.8	369.0	373.9	388.1	373.1	382.0	378.0
04/15/94	385.22	368.6	368.6	379.0	379.4	374.3	372.3	372.2	381.6	372.0	380.4	371.8	380.5	370.5	381.3	369.1	371.9	369.6	373.6	397.7	373.2	381.8	377.7
04/16/94	385.04	368.6	368.4	379.1	379.3	374.2	372.2	372.2	381.7	372.1	380.5	371.9	380.7	370.6	381.5	368.9	371.8	369.3	375.1	382.3	373.8	399.4	377.7
04/17/94	385.21	368.6	368.3	379.0	379.4	374.2	372.3	372.2	381.8	372.2	380.6	371.9	380.7	370.7	381.6	368.7	371.8	369.3	374.0	382.0	373.2	405.2	377.7
04/18/94	384.47	368.3	368.1	379.0	379.3	374.0	372.1	372.0	381.5	372.0	380.4	371.7	380.5	370.5	381.3	368.7	371.6	369.0	373.7	402.3	373.0	381.9	377.5
04/19/94	383.12	366.7	366.5	378.4	378.7	373.1	371.0	371.4	381.4	371.5	380.2	371.5	380.4	370.3	381.2	367.1	370.7	367.4	373.4	393.1	372.4	381.8	377.1
05/02/94	383.51	365.1	364.9	376.8	377.8	371.5	369.4	370.1	380.4	370.3	379.3	370.5	379.4	369.2	380.2	365.4	369.3	365.9	374.1	396.8	371.2	380.8	376.2
05/24/94	382.56	364.6	364.4	376.5	377.3	371.2	369.0	369.8	380.2	370.1	379.1	370.4	379.2	369.2	380.0	364.9	369.0	362.2	372.1	387.6	371.0	381.1	375.6
06/27/94	380.05	363.8	363.5	375.4	376.1	370.2	368.0	368.8	379.6	369.0	378.7	369.1	378.7	367.8	379.6	364.1	368.0	365.1	370.7	400.8	369.9	380.3	374.6
08/01/94	379.88	363.9	363.6	374.3	376.0	370.0	367.8	368.6	379.8	368.8	378.6	368.9	378.7	367.7	379.6	364.2	367.9	365.6	370.5	386.9	369.7	380.2	369.2
09/01/94	379.80	363.7	363.5	374.8	375.6	369.7	367.6	368.4	379.7	368.6	378.5	368.9	378.5	367.5	379.5	364.0	367.6	365.2	370.3	387.0	369.5	380.1	371.4
10/03/94	382.18	363.9	363.7	375.1	376.3	370.1	368.0	368.9	381.7	369.1	380.2	369.4	380.1	368.0	381.5	364.2	368.3	365.7	370.8	386.8	370.0	381.3	375.6
10/28/94	382.11	364.0	363.7	375.2	375.9	370.0	367.7	368.8	381.7	368.9	380.1	369.1	380.1	367.6	381.4	364.1	367.8	365.6	370.5	386.1	369.8	381.6	377.4
12/02/94	384.05	363.7	363.6	375.0	372.7	370.0	367.8	369.3	379.2	369.4	379.1	368.7	379.3	368.2	380.7	364.1	368.0	365.3	370.6	388.2	369.8	380.4	377.4
03/02/95	382.78	PI	PI	375.6	375.9	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
03/28/95	383.84	365.8	365.6	377.1	377.1	372.0	369.7	370.3	382.1	370.6	380.7	370.5	380.8	369.2	382.0	366.3	369.7	367.0	372.3	386.0	371.4	382.4	377.8
05/01/95	381.76	363.6	363.4	376.1	376.2	370.3	368.1	368.4	380.5	368.6	379.0	368.9	379.3	367.8	379.8	364.5	367.3	365.1	371.0	383.0	369.8	382.0	374.7
05/26/95	380.96	363.7	363.5	375.6	376.0	370.3	368.0	368.8	379.9	368.9	378.7	369.1	378.7	368.0	379.7	364.5	367.9	365.2	370.8	382.0	369.7	380.5	374.8
06/27/95	379.60	363.7	363.5	375.2	375.4	369.8	367.6	368.3	379.4	368.4	378.3	368.5	378.3	367.2	379.3	364.1	367.5	365.1	370.3	383.9	369.2	379.9	373.6
07/26/95	379.21	363.8	363.6	374.8	375.3	369.7	367.5	368.4	379.9	368.2	378.7	368.3	378.7	367.0	379.7	364.3	367.5	365.4	370.0	383.8	369.1	381.0	374.3
08/31/95	380.02	364.2	363.9	374.7	375.3	369.7	367.4	368.1	379.6	368.1	378.4	368.3	378.4	367.0	379.3	364.4	367.5	365.3	369.1	370.6	369.9	381.8	373.3
09/29/95	380.16	364.0	363.8	374.6	375.4	369.7	367.5	368.1	380.2	368.1	378.6	368.2	378.6	366.8	379.7	364.6	367.1	365.3	369.9	383.3	368.9	380.0	373.7
10/29/95	389.70	368.1	367.8	377.3	378.3	372.9	371.3	371.1	381.9	371.1	380.9	370.9	381.0	369.4	381.6	368.3	370.8	369.3	373.1	405.2	372.2	381.9	375.9
10/30/95	388.53	368.5	368.4	377.8	378.2	371.6	373.3	371.3	382.0	371.1	380.9	370.8	381.0	369.0	381.7	365.4	371.1	370.2	372.8	398.8	372.2	381.8	375.6
10/31/95	385.80	368.2	368.1	377.7	377.8	373.2	374.1	370.9	381.9	370.7	380.6	370.5	380.7	368.8	381.8	368.4	370.7	369.6	372.3	391.9	371.8	378.7	375.7
11/01/95	386.91	367.8	367.6	377.5	377.7	372.9	371.0	370.9	382.1	370.8	380.9	368.9	380.9	369.2	381.9	368.1	370.6	368.4	372.5	387.0	371.9	379.0	375.5
11/02/95	383.17	367.5	367.3	377.4	375.3	372.6	370.5	370.7	381.6	370.5	380.6	370.4	380.5	369.1	381.6	367.7	370.4	368.6	372.0	388.4	371.5	382.0	376.1
11/03/95	385.81	368.4	368.1	377.7	378.5	373.3	371.4	371.2	382.0	371.1	380.9	370.8	380.8	369.5	381.8	368.5	370.9	369.6	372.9	398.3	372.2	382.4	376.4
11/04/95	386.35	368.2	364.7	377.8	378.4	373.1	374.6	371.1	382.2	371.0	381.0	371.0	381.0	369.5	382.0	368.3	370.8	369.3	372.9	394.7	371.9	382.2	376.7
11/05/95	385.03	367.4	367.0	377.6	378.1	372.7	371.0	371.1	382.1	370.9	380.9	371.0	380.9	369.5	381.9	367.7	370.5	368.7	372.6	391.2	371.9	382.1	376.3
11/06/95	384.85	366.7	366.4	377.3	377.9	372.4	370.2	370.7	381.9	370.6	380.8	370.7	380.8	369.3	381.8	367.1	370.0	368.0	372.3	387.0	371.5	388.7	376.0
11/07/95	384.53	366.2	365.9	377.1	377.6	372.1	370.2	370.4	382.0	370.5	380.8	370.6	380.7	369.2	381.8	366.7	369.7	367.2	369.0	386.4	369.2	384.1	375.8
11/13/95	388.50	367.9	367.7	377.5	378.6	372.9	371.1	371.2	382.0	371.2	381.0	371.1	381.0	369.8	381.8	368.1	370.8	368.8	373.2	395.2	372.2	382.1	376.0
11/14/95	384.91	368.0	367.8	377.8	378.4	373.2	371.2	371.2	381.9	367.8	380.8	370.8	380.8	369.6	381.8	368.2	368.1	369.2	372.5	390.1	372.0	379.0	376.1
11/15/95	389.71	367.7	367.4	377.6	379.1	372.9	371.1	371.2	381.8	371.3	380.9	371.3	381.0	370.1	381.8	367.9	370.8	368.6	373.3	404.2	372.9	382.8	376.0
11/16/95	390.03	368.1	368.1	378.2	379.1	373.5	371.8	371.6	382.0	371.6	381.0	371.5	381.1	370.2	381.9	368.4	371.2	369.5	373.5	395.6	372.5	382.2	376.3
11/17/95	389.65	368.3	368.3	378.3	379.0	373.6	371.5	371.6	382.1	371.6	381.1	371.5	381.1	370.2	381.9	368.6	371.2	369.8	373.4	391.8	372.7	384.1	376.3
11/18/95	386.62	368.3	368.2	378.3	378.5	373.5	371.5	371.0	382.1	371.3	380.9	371.1	380.9	369.9	382.0	368.6	371.1	369.4	372.9	388.5	372.3	382.3	376.2
11/19/95	384.58	367.6	367.4	378.0	378.2	373.0	370.9	371.1	381.9	371.0	380.7	371.0	380.7	369.8	381.9	367.8	370.7	368.3	369.0	386.8	369.3	384.3	376.0
11/20/95	383.30	367.0	366.8	377.6	378.1	372.7	370.4	370.9	381.8	370.9	377.4	370.9	380.7	369.7	381.8	367.4	370.5	367.9	372.3	390.0	371.6	382.4	375.9
11/21/95	383.60	367.2	366.9	377.8	378.0	372.8	370.6	370.8	381.9	370.7	380.6	370.9	380.6	369.6	381.7	367.5	370.5	368.1	372.6	388.9	371.8	382.3	375.5
11/22/95	385.66	366.2	366.2	377.4	378.1	372.4	370.3	370.8	381.8	370.9	380.7	371.0	380.7	369.8	381.8	366.8	370.2	367.5	372.6	389.7	371.7	384.1	375.6
12/27/95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
01/22/96	389.05	367.8	367.6	378.0	377.1	373.2	371.0	371.2	381.9	371.1	380.8	371.0	380.9	369.6	381.9	368.1	370.9	368.9	373.1	383.8	372.2	382.0	PF
01/23/96	388.20	368.0	367.8	378.1	377.2	373.3	371.0	371.2	381.9	371.1	380.8	370.9	380.8	369.6	381.8	368.3	370.9	368.9	372.8	384.1	372.2	382.1	376.3
01/24/96	384.67	367.7	367.4	378.1	377.1	373.2	370.8	371.2	381.4	371.0	380.4	370.8	380.5	369.5	381.8	368.0	370.9	368.6	372.4	384.9	371.9	382.1	376.4
01/25/96	390.00	367.7	367.5	377.6	377.6	373.0	370.8	371.1	382.2	371.2	381.0	371.1	381.0	369.8	382.0	368.0	370.8	368.6	373.1	394.1	372.1	381.7	376.5
01/26/96	388.85	368.6	368.8	378.4	377.7	373.7	371.6	371.5	382.0	371.5	381.0	371.1	380.9	369.7	381.9	368.9	371.4	369.6	373.2	396.5	372.5	381.6	376.8
01/27/96	386.67	368.3	368.2	378.5	377.5	373.7	371.5	371.4	381.8	371.2	380.6	371.0	380.7	369.7	381.7	368.6	371.1	369.4	372.4	382.3			376.7
01/28/96	391.02	367.8	367.1	378.5	378.5	373.6	371.6	371.7	382.0	371.8	381.0	371.7	381.0	370.4	382.0	368.1	371.2	368.9	373.8	399.8	372.9	382.0	377.0
01/29/96	393.59	367.9	367.5	378.6	378.8	373.7	372.0	371.9	382.1	372.1	381.2	371.9	381.2	370.6	382.0	368.3	371.4	369.1	373.3	397.1	372.9	381.9	377.1
01/30/96	393.86	368.7	368.4	379.2	378.9	374.3	372.5	372.3	382.2	372.3	381.3	372.1	381.4	370.8	382.1	369.0	372.0	370.2	374.3	393.7	373.3	382.6	377.1
01/31/96	391.20	368.5	368.3	379.1	378.7	374.2	372.3	372.1	382.0	371.9	381.1	371.8	381.2	370.5	381.9	368.9	371.7	370.5	373.7	390.0	372.9	382.2	376.8
02/01/96	386.03	368.2	367.9	378.8	378.0	373.7	371.5	371.4	381.8	371.2	380.6	371.1	380.7	370.0	381.7	368.6	371.2	369.7	372.7	386.6	372.3	381.9	376.4
02/02/96	383.94	367.4	367.1	378.2	377.6	373.1	370.7	371.0	381.8	371.2	380.4	370.9	380.4	369.7	381.7	367.7	370.6	368.2	372.5	385.6	371.9	382.0	376.3
02/03/96	383.50	366.5	366.1	377.9	377.5	372.6	370.3	370.8	381.7	370.9	380.3	371.0	380.3	369.8	381.6	366.9	370.2	367.4	PI	PI	PI	PI	376.1
02/04/96	384.10	368.1	364.5	377.4	377.2	371.8	371.4	370.3	PI	370.6	380.4	370.8	380.4	369.7	381.8	365.4	369.4	365.8	PI	PI	PI	PI	376.0

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
02/05/96	384.56	365.7	365.4	377.3	377.1	372.0	369.7	370.3	381.9	370.5	380.4	370.7	380.4	382.1	369.6	366.2	369.6	366.5	PI	PI	PI	PI	375.8
02/06/96	383.90	364.2	364.0	376.9	376.9	371.4	369.1	369.9	PI	370.2	380.2	370.5	380.3	369.4	PI	364.9	368.9	365.4	PI	PI	PI	PI	375.4
02/08/96	384.60	364.6	364.4	376.7	376.6	371.3	368.9	369.9	PI	370.2	380.5	370.6	380.7	370.2	PI	365.2	369.0	365.7	PI	PI	PI	PI	375.4
02/28/96	383.60	367.0	367.0	378.1	376.9	373.0	370.6	371.0	382.3	371.1	380.3	371.0	380.4	369.8	382.1	367.5	370.6	368.2	372.8	384.7	372.0	382.1	375.3
03/28/96	384.30	365.7	365.5	377.2	376.9	372.0	369.6	370.3	381.8	370.5	380.5	370.5	380.5	369.3	382.0	366.1	369.6	367.0	372.4	383.9	371.4	382.0	375.1
04/17/96	395.00	363.7	363.3	377.9	379.7	372.0	371.0	371.2	370.5	371.8	381.5	372.6	381.6	370.4	381.7	364.7	369.5	365.4	374.9	402.8	372.7	384.3	375.3
04/18/96	400.10	363.8	363.5	378.0	379.9	372.1	371.1	371.2	370.6	372.2	381.5	372.6	381.6	371.4	381.8	364.8	369.6	365.5	375.1	402.9	372.8	384.4	375.4
04/20/96	401.40	369.0	369.2	379.9	379.8	375.0	373.3	373.0	382.2	373.0	381.9	372.9	382.1	371.6	382.1	369.5	372.6	370.9	375.0	389.1	374.8	382.7	377.2
04/22/96	397.10	368.7	368.8	379.9	379.1	374.6	372.8	372.4	382.0	372.4	381.4	372.2	381.5	371.1	381.9	369.2	372.1	370.7	372.6	383.5	375.1	388.4	376.9
04/23/96	395.60	368.9	368.7	379.7	379.2	374.6	372.6	372.5	382.1	372.4	381.4	372.2	381.6	371.0	382.3	369.2	372.3	370.8	373.4	382.6	373.7	391.0	377.5
04/24/96	395.60	368.6	368.2	379.5	379.5	374.4	372.5	372.2	382.3	372.2	381.3	371.8	381.6	370.8	382.3	369.0	372.0	370.6	373.2	382.7	373.5	395.7	377.4
04/25/96	389.90	368.4	368.4	378.9	378.8	373.8	371.7	371.6	378.7	371.5	380.7	371.3	380.7	370.2	381.9	368.5	371.3	370.0	372.9	392.3	372.0	382.1	377.0
04/26/96	386.40	368.2	368.1	378.9	378.6	373.9	371.4	371.4	381.8	371.2	380.5	370.9	380.4	370.0	381.7	368.4	370.9	369.7	372.8	390.4	372.4	382.3	376.8
04/27/96	386.89	367.7	367.5	378.6	378.5	373.6	371.3	371.5	382.0	371.5	380.8	371.3	380.8	370.2	381.9	368.1	371.1	368.8	372.5	382.1	373.0	388.7	377.1
04/28/96	384.23	366.8	366.5	378.1	378.1	373.1	370.8	371.1	381.9	371.1	380.6	371.0	380.6	370.0	381.8	367.2	370.6	368.0	372.6	388.1	371.9	381.8	377.0
04/29/96	383.50	366.7	366.5	378.0	377.9	372.8	370.5	370.9	381.9	370.9	380.5	370.7	380.5	369.8	381.8	367.1	370.4	367.7	372.2	387.8	371.8	382.1	376.7
04/30/96	384.30	366.7	366.4	378.0	378.3	372.8	370.5	371.0	381.9	371.1	380.6	371.0	380.6	370.0	381.8	367.1	370.4	367.7	390.7	382.6	383.9	372.6	376.9
06/04/96	380.57	363.5	363.3	376.0	376.7	370.5	368.2	369.1	379.9	369.5	378.8	369.8	378.9	368.9	379.7	364.1	368.2	364.9	NA	NA	NA	NA	NA
07/01/96	380.00	363.5	363.3	375.5	375.9	370.1	367.8	368.7	379.8	369.0	378.7	369.2	378.7	368.2	379.7	364.0	367.8	365.0	370.8	385.0	369.7	380.4	374.2
07/29/96	380.29	363.5	363.2	375.3	375.9	370.0	367.7	368.6	379.7	369.0	378.6	369.2	378.6	368.2	379.6	364.0	367.8	364.8	370.7	384.5	369.5	380.2	375.1
08/28/96	380.11	363.8	363.5	375.1	375.3	369.9	367.6	368.2	379.6	368.4	378.4	368.4	378.4	367.3	379.4	364.2	367.5	365.1	370.2	383.5	369.2	380.1	375.2
09/29/96	379.91	363.9	363.6	374.9	375.6	369.8	367.5	368.2	379.6	368.4	378.4	368.4	378.4	367.3	379.4	364.2	367.5	365.2	369.2	379.9	370.0	386.4	375.0
10/21/96	392.44	364.9	364.7	376.2	377.4	371.3	369.5	370.4	382.0	370.9	381.1	370.9	381.1	369.5	381.9	365.4	369.1	366.4	373.5	408.9	371.9	381.8	376.9
10/22/96	401.65	364.8	364.6	376.9	379.1	371.8	371.0	370.9	382.1	371.7	381.7	371.9	381.7	370.5	382.0	365.4	369.5	366.4	374.6	396.7	372.4	382.1	377.1
10/23/96	401.80	368.5	368.3	377.8	379.4	373.5	372.2	372.1	382.3	372.3	382.0	372.3	382.2	370.9	382.1	368.6	371.6	370.0	374.6	380.0	373.4	382.2	377.9
10/24/96	403.17	368.5	368.3	378.6	379.0	374.0	372.5	372.2	382.1	372.2	381.9	372.1	382.0	370.7	382.1	368.8	371.7	370.2	374.3	391.1	373.3	382.3	377.9
10/25/96	401.36	368.4	368.4	378.7	378.5	373.9	372.3	371.9	382.2	372.0	381.7	371.8	381.7	370.5	381.9	368.8	371.6	370.6	373.8	389.0	372.7	382.1	377.8
10/26/96	401.00	368.5	368.4	378.6	378.2	373.8	372.0	371.8	382.1	371.7	381.4	371.5	381.6	370.2	382.0	368.7	371.5	370.5	373.3	389.1	372.7	382.0	377.8
10/27/96	397.60	368.4	368.3	378.5	378.0	373.7	371.8	371.5	382.0	371.5	381.2	371.3	381.3	370.0	381.9	368.7	371.3	370.5	373.0	389.9	372.4	382.1	377.7
10/28/96	393.85	368.2	368.3	378.3	377.8	373.5	371.6	370.9	381.9	370.5	380.9	370.1	381.0	368.7	381.7	368.5	371.0	370.8	372.1	390.8	371.7	382.2	377.4
10/29/96	386.84	368.1	368.1	377.9	377.2	373.1	370.8	370.6	381.7	370.2	380.5	369.9	380.6	368.8	381.7	368.4	370.6	370.2	371.2	390.9	371.1	381.7	377.4
10/30/96	383.80	366.9	366.6	377.2	376.8	372.2	369.7	370.2	381.9	369.9	380.3	369.8	380.4	368.7	381.8	367.2	369.7	368.2	371.1	391.0	370.8	382.3	377.0
10/31/96	383.53	366.2	365.9	376.9	376.7	371.8	369.4	369.9	381.8	369.9	380.3	369.8	380.3	368.8	381.8	366.6	369.4	367.6	371.4	390.8	370.7	382.0	376.8
11/01/96	383.70	364.3	364.0	376.6	376.7	371.3	369.0	369.6	381.8	369.9	380.3	370.1	380.3	369.0	381.7	364.9	368.6	366.1	371.6	390.4	370.5	381.9	376.4
11/02/96	384.50	365.4	365.1	377.4	376.8	371.4	369.1	369.9	382.1	369.9	380.6	370.2	380.6	369.0	381.9	365.8	369.1	366.8	371.3	390.4	370.7	382.0	376.6
11/03/96	383.40	364.2	364.0	376.1	376.6	370.9	368.6	369.4	381.8	369.6	380.3	369.8	380.3	368.8	381.6	364.8	368.4	366.0	371.3	389.9	370.3	381.8	376.0
11/10/96	389.60	368.4	368.1	377.2	377.2	372.6	370.3	371.0	382.1	371.0	381.3	371.0	381.3	369.7	382.3	368.2	370.9	368.8	372.9	398.9	371.9	382.2	377.0
11/11/96	386.60	367.4	367.1	377.6	377.4	373.1	370.7	371.1	382.2	370.9	381.0	370.8	381.0	369.4	382.1	367.7	370.6	368.8	369.3	391.9	PI	PI	376.9
11/12/96	386.10	368.3	368.0	377.9	377.5	373.4	371.1	371.2	382.5	371.1	381.1	370.8	381.2	369.5	382.3	368.5	370.9	369.3	372.7	388.3	372.1	382.2	377.2
11/13/96	383.65	367.4	367.2	377.7	377.3	372.8	370.5	370.8	381.9	370.6	380.6	370.4	380.6	369.2	381.7	367.6	370.3	368.5	372.1	387.6	371.5	382.1	376.7
11/14/96	383.80	367.3	367.1	377.6	377.2	372.8	370.5	370.7	382.0	370.6	380.7	370.4	380.7	369.1	381.8	367.6	370.3	368.4	372.3	387.2	371.6	382.2	376.8
11/15/96	384.22	365.5	365.3	377.2	377.1	371.9	369.6	370.1	381.8	370.3	380.5	370.2	380.4	368.9	381.7	366.0	369.4	366.7	372.1	386.8	371.4	382.0	376.4
11/29/96	383.81	365.1	364.9	376.6	376.8	371.4	369.0	369.8	381.9	370.1	380.5	370.2	380.4	369.0	381.7	365.5	369.0	366.4	371.6	390.1	370.5	382.0	376.1
12/31/96	385.42	367.1	366.9	378.3	378.7	373.2	370.9	371.2	382.0	371.3	380.8	371.2	380.8	370.1	381.9	367.5	370.7	368.4	PI	PI	PI	PI	377.0
03/31/97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/21/97	398.04	368.3	368.0	378.6	379.9	373.8	372.0	372.3	382.1	372.7	381.7	372.4	381.8	371.4	382.0	368.5	368.5	369.3	374.9	395.0	373.3	382.5	376.4
04/22/97	398.20	369.0	368.7	379.7	379.9	374.8	373.0	372.8	382.2	372.9	381.8	372.8	378.6	371.5	382.0	372.6	372.4	370.3	375.2	392.4	373.8	382.8	376.8
04/23/97	397.03	368.9	368.7	379.8	379.6	374.4	372.5	372.6	382.1	372.7	381.6	372.5	381.7	371.3	382.0	369.2	372.3	370.2	374.6	390.2	373.4	382.7	376.6
04/24/97	394.28	369.3	369.0	379.8	379.2	374.8	372.6	372.5	382.3	372.4	381.5	372.2	381.6	371.0	382.1	369.5	372.4	370.5	374.2	389.8	373.4	382.4	376.7
04/25/97	392.17	369.0	368.7	379.5	378.7	374.6	372.3	372.1	382.2	372.1	381.2	371.8	381.3	370.7	382.1	369.3	372.1	370.2	373.1	382.3	373.5	389.7	376.4
04/26/97	385.98	368.2	367.9	379.1	378.3	373.9	371.4	371.5	381.9	371.3	380.7	371.1	380.8	370.1	381.8	368.5	371.3	369.5	372.5	389.5	372.2	382.1	376.0
04/27/97	383.05	366.8	366.6	378.2	377.8	374.2	370.3	370.8	382.0	371.0	380.5	370.3	380.5	369.9	382.0	367.2	370.5	368.3	372.5	389.1	371.6	382.1	375.6
04/28/97	383.35	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/29/97	385.02	367.5	367.2	378.2	378.9	373.2	370.9	371.2	382.1	371.4	380.8	371.3	380.7	370.2	381.9	367.7	370.9	368.8	372.2	382.3	373.0	398.7	375.7
04/30/97	383.52	367.1	366.9	378.2	378.7	372.8	370.8	371.1	381.8	371.1	380.4	371.1	380.6	370.1	381.6	367.5	370.6	368.5	372.9	392.2	371.9	382.3	375.4

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B
31-Jan-92	382.70	363.8	363.6	376.1	375.9	370.7	367.8	369.1	381.5	369.5	380.1
03-Mar-92	382.70	364.0	363.8	375.9	375.7	370.7	367.9	369.1	381.9	369.4	380.1
03-Apr-92	384.20	365.3	365.4	376.9	376.7	371.8	369.1	370.0	381.7	370.3	PI
30-Apr-92	380.98	365.7	365.4	377.1	377.4	371.9	369.2	369.7	379.4	369.8	379.0
02-Jun-92	384.96	366.3	366.5	376.6	377.8	371.7	369.4	369.6	379.8	369.9	379.0
01-Jul-92	380.15	363.7	363.5	375.6	375.9	370.3	367.7	368.5	379.3	368.8	378.6
04-Aug-92	380.12	363.8	363.6	375.4	376.0	370.2	367.7	368.3	379.4	368.6	378.6
01-Sep-92	380.00	363.8	363.6	375.3	375.8	370.2	367.6	368.2	379.4	368.5	378.5
28-Sep-92	380.57	364.7	364.5	375.7	376.1	370.7	368.1	368.6	380.0	368.8	378.9
30-Oct-92	382.12	363.9	363.6	375.3	375.8	370.1	367.6	368.2	381.2	368.4	380.1
30-Nov-92	384.00	366.3	366.1	377.0	377.2	372.0	369.7	370.0	381.7	370.1	380.3
31-Dec-92	384.00	365.0	364.8	376.2	376.1	371.2	368.6	369.4	382.0	369.6	380.6
29-Jan-93	384.00	364.3	364.1	376.6	376.2	371.3	368.6	369.3	381.9	369.6	380.4
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
02-May-93	365.50	368.9	365.3	377.5	377.6	372.2	369.6	370.1	380.1	370.5	379.2
28-May-93	365.50	363.7	363.5	375.9	376.1	370.5	367.9	368.7	379.6	369.1	378.5
01-Jul-93	365.50	363.8	363.5	375.3	375.6	370.1	367.6	368.2	379.5	368.5	378.5
31-Jul-93	365.50	364.2	363.9	375.2	375.4	370.1	367.6	368.2	379.8	368.4	378.8
01-Sep-93	380.19	364.0	363.8	375.0	375.2	370.0	367.5	368.0	379.7	368.2	378.7
29-Sep-93	380.18	363.8	363.6	374.8	376.0	369.4	367.5	367.9	379.6	368.2	378.4
02-Nov-93	383.13	364.2	364.0	375.0	376.2	370.2	367.8	368.6	381.7	368.9	380.3
01-Dec-93	384.10	366.3	366.1	376.7	377.1	371.9	369.4	370.2	381.7	370.2	380.4
29-Dec-93	383.50	363.7	363.5	375.9	376.5	370.6	368.0	369.3	381.5	369.6	380.2
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	375.0	375.7	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	367.1	PI	377.8	377.9	372.9	370.8	371.2	PI	371.2	380.0
02-May-94	383.51	365.1	364.9	376.8	377.8	371.5	369.4	370.1	380.4	370.3	379.3
24-May-94	382.56	364.6	364.4	376.5	377.3	371.2	369.0	369.8	380.2	370.1	379.1
27-Jun-94	380.05	363.8	363.5	375.4	376.1	370.2	368.0	368.8	379.6	369.0	378.7
01-Aug-94	379.88	363.9	363.6	374.3	376.0	370.0	367.8	368.6	379.8	368.8	378.6
01-Sep-94	379.80	363.7	363.5	374.8	375.6	369.7	367.6	368.4	379.7	368.6	378.5
03-Oct-94	382.18	363.9	363.7	375.1	376.3	370.1	368.0	368.9	381.7	369.1	380.2
28-Oct-94	382.11	364.0	363.7	375.2	375.9	370.0	367.7	368.8	381.7	368.9	380.1
02-Dec-94	384.05	363.7	363.6	375.0	372.7	370.0	367.8	369.3	379.2	369.4	379.1
02-Mar-95	382.78	PI	PI	375.6	375.9	PI	PI	PI	PI	PI	PI
28-Mar-95	383.84	365.8	365.6	377.1	377.1	372.0	369.7	370.3	382.1	370.6	380.7
01-May-95	381.76	363.6	363.4	376.1	376.2	370.3	368.1	368.4	380.5	368.6	379.0
26-May-95	380.96	363.7	363.5	375.6	376.0	370.3	368.0	368.8	379.9	368.9	378.7
27-Jun-95	379.60	363.7	363.5	375.2	375.4	369.8	367.6	368.3	379.4	368.4	378.3
26-Jul-95	379.21	363.8	363.6	374.8	375.3	369.7	367.5	368.4	379.9	368.2	378.7
31-Aug-95	380.02	364.2	363.9	374.7	375.3	369.7	367.4	368.1	379.6	368.1	378.4
29-Sep-95	380.16	364.0	363.8	374.6	375.4	369.7	367.5	368.1	380.2	368.1	378.6
07-Nov-95	384.53	366.2	365.9	377.1	377.6	372.1	370.2	370.4	382.0	370.5	380.8
22-Nov-95	385.66	366.2	366.2	377.4	378.1	372.4	370.3	370.8	381.8	370.9	380.7
27-Dec-95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
08-Feb-96	384.60	364.6	364.4	376.7	376.6	371.3	368.9	369.9	PI	370.2	380.5
28-Feb-96	383.60	367.0	367.0	378.1	376.9	373.0	370.6	371.0	382.3	371.1	380.3
28-Mar-96	384.30	365.7	365.5	377.2	376.9	372.0	369.6	370.3	381.8	370.5	380.5
30-Apr-96	384.30	366.7	366.4	378.0	378.3	372.8	370.5	371.0	381.9	371.1	380.6
04-Jun-96	380.57	363.5	363.3	376.0	376.7	370.5	368.2	369.1	379.9	369.5	378.8
01-Jul-96	380.00	363.5	363.3	375.5	375.9	370.1	367.8	368.7	379.8	369.0	378.7
29-Jul-96	380.29	363.5	363.2	375.3	375.9	370.0	367.7	368.6	379.7	369.0	378.6
28-Aug-96	380.11	363.8	363.5	375.1	375.3	369.9	367.6	368.2	379.6	368.4	378.4
29-Sep-96	379.91	363.9	363.6	374.9	375.6	369.8	367.5	368.2	379.6	368.4	378.4
03-Nov-96	383.40	364.2	364.0	376.1	376.6	370.9	368.6	369.4	381.8	369.6	380.3
29-Nov-96	383.81	365.1	364.9	376.6	376.8	371.4	369.0	369.8	381.9	370.1	380.5
31-Dec-96	385.42	367.1	366.9	378.3	378.7	373.2	370.9	371.2	382.0	371.3	380.8
31-Mar-97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
30-Apr-97	383.52	367.1	366.9	378.2	378.7	372.8	370.8	371.1	381.8	371.1	380.4
Average Water level:	381.28	364.71	364.40	376.02	376.38	370.89	368.54	369.23	380.62	369.43	379.46

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD

DATE	POOL EL	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A
31-Jan-92	382.70	369.8	380.2	368.6	381.9	364.2	368.3	365.2	NA	NA	NA
03-Mar-92	382.70	369.7	380.2	368.4	381.9	364.5	368.2	381.1	NA	NA	NA
03-Apr-92	384.20	370.4	380.5	369.2	PI	365.6	369.3	367.3	NA	NA	NA
30-Apr-92	380.98	370.2	379.2	368.9	379.7	365.9	369.2	367.2	NA	NA	NA
02-Jun-92	384.96	370.2	379.0	368.6	380.0	366.1	369.3	367.2	NA	NA	NA
01-Jul-92	380.15	369.1	378.7	367.8	379.7	364.1	367.8	365.2	NA	NA	NA
04-Aug-92	380.12	368.9	378.7	367.7	379.6	364.1	367.6	365.2	NA	NA	NA
01-Sep-92	380.00	368.8	378.5	367.4	379.6	364.0	367.5	365.4	NA	NA	NA
28-Sep-92	380.57	368.9	379.0	367.6	380.0	364.9	368.1	366.2	NA	NA	NA
30-Oct-92	382.12	368.6	380.2	367.0	381.4	364.1	367.7	365.7	NA	NA	NA
30-Nov-92	384.00	370.1	380.5	368.8	381.5	366.8	369.5	367.6	NA	NA	NA
31-Dec-92	384.00	369.8	380.9	368.4	381.9	365.4	368.8	366.4	NA	NA	NA
29-Jan-93	384.00	369.8	380.8	368.4	PF	365.0	368.5	366.1	NA	NA	NA
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA
02-May-93	365.50	370.6	379.6	369.6	380.2	365.9	369.6	366.6	NA	NA	NA
28-May-93	365.50	369.4	378.6	368.2	379.6	364.1	368.0	364.9	NA	NA	NA
01-Jul-93	365.50	368.8	378.8	367.4	379.6	364.0	367.6	365.1	NA	NA	NA
31-Jul-93	365.50	368.6	379.3	367.2	379.9	364.0	367.7	365.5	NA	NA	NA
01-Sep-93	380.19	368.4	379.0	366.9	379.8	364.2	367.5	365.5	NA	NA	NA
29-Sep-93	380.18	368.5	378.6	367.0	379.5	363.9	367.4	365.4	NA	NA	NA
02-Nov-93	383.13	369.2	380.6	367.7	381.7	364.4	367.9	365.9	NA	NA	NA
01-Dec-93	384.10	369.9	380.7	368.4	381.6	366.4	369.5	367.4	NA	NA	NA
29-Dec-93	383.50	369.7	380.5	368.4	381.5	364.3	368.2	365.4	NA	NA	NA
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	371.1	380.2	369.2	PI	367.5	370.6	367.7	372.9	386.8	372.2
02-May-94	383.51	370.5	379.4	369.2	380.2	365.4	369.3	365.9	374.1	396.8	371.2
24-May-94	382.56	370.4	379.2	369.2	380.0	364.9	369.0	362.2	372.1	387.6	371.0
27-Jun-94	380.05	369.1	378.7	367.8	379.6	364.1	368.0	365.1	370.7	400.8	369.9
01-Aug-94	379.88	368.9	378.7	367.7	379.6	364.2	367.9	365.6	370.5	386.9	369.7
01-Sep-94	379.80	368.9	378.5	367.5	379.5	364.0	367.6	365.2	370.3	387.0	369.5
03-Oct-94	382.18	369.4	380.1	368.0	381.5	364.2	368.3	365.7	370.8	386.8	370.0
28-Oct-94	382.11	369.1	380.1	367.6	381.4	364.1	367.8	365.6	370.5	386.1	369.8
02-Dec-94	384.05	368.7	379.3	368.2	380.7	364.1	368.0	365.3	370.6	388.2	369.8
02-Mar-95	382.78	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
28-Mar-95	383.84	370.5	380.8	369.2	382.0	366.3	369.7	367.0	372.3	386.0	371.4
01-May-95	381.76	368.9	379.3	367.8	379.8	364.5	367.3	365.1	371.0	383.0	369.8
26-May-95	380.96	369.1	378.7	368.0	379.7	364.5	367.9	365.2	370.8	382.0	369.7
27-Jun-95	379.60	368.5	378.3	367.2	379.3	364.1	367.5	365.1	370.3	383.9	369.2
26-Jul-95	379.21	368.3	378.7	367.0	379.7	364.3	367.5	365.4	370.0	383.8	369.1
31-Aug-95	380.02	368.3	378.4	367.0	379.3	364.4	367.5	365.3	369.1	370.6	369.9
29-Sep-95	380.16	368.2	378.6	366.8	379.7	364.6	367.1	365.3	369.9	383.3	368.9
07-Nov-95	384.53	370.6	380.7	369.2	381.8	366.7	369.7	367.2	369.0	386.4	369.2
22-Nov-95	385.66	371.0	380.7	369.8	381.8	366.8	370.2	367.5	372.6	389.7	371.7
27-Dec-95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
08-Feb-96	384.60	370.6	380.7	370.2	PI	365.2	369.0	365.7	PI	PI	PI
28-Feb-96	383.60	371.0	380.4	369.8	382.1	367.5	370.6	368.2	372.8	384.7	372.0
28-Mar-96	384.30	370.5	380.5	369.3	382.0	366.1	369.6	367.0	372.4	383.9	371.4
30-Apr-96	384.30	371.0	380.6	370.0	381.8	367.1	370.4	367.7	390.7	382.6	383.9
04-Jun-96	380.57	369.8	378.9	368.9	379.7	364.1	368.2	364.9	NA	NA	NA
01-Jul-96	380.00	369.2	378.7	368.2	379.7	364.0	367.8	365.0	370.8	385.0	369.7
29-Jul-96	380.29	369.2	378.6	368.2	379.6	364.0	367.8	364.8	370.7	384.5	369.5
28-Aug-96	380.11	368.4	378.4	367.3	379.4	364.2	367.5	365.1	370.2	383.5	369.2
29-Sep-96	379.91	368.4	378.4	367.3	379.4	364.2	367.5	365.2	369.2	379.9	370.0
03-Nov-96	383.40	369.8	380.3	368.8	381.6	364.8	368.4	366.0	371.3	389.9	370.3
29-Nov-96	383.81	370.2	380.4	369.0	381.7	365.5	369.0	366.4	371.6	390.1	370.5
31-Dec-96	385.42	371.2	380.8	370.1	381.9	367.5	370.7	368.4	PI	PI	PI
31-Mar-97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
30-Apr-97	383.52	371.1	380.6	370.1	381.6	367.5	370.6	368.5	372.9	392.2	371.9
Average Water level:	381.28	369.57	379.58	368.33	380.54	365.03	368.52	366.27	371.78	386.15	370.73

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD

DATE	POOL EL	PZ-14B	PZ-15
31-Jan-92	382.70	NA	NA
03-Mar-92	382.70	NA	NA
03-Apr-92	384.20	NA	NA
30-Apr-92	380.98	NA	NA
02-Jun-92	384.96	NA	NA
01-Jul-92	380.15	NA	NA
04-Aug-92	380.12	NA	NA
01-Sep-92	380.00	NA	NA
28-Sep-92	380.57	NA	NA
30-Oct-92	382.12	NA	NA
30-Nov-92	384.00	NA	NA
31-Dec-92	384.00	NA	NA
29-Jan-93	384.00	NA	NA
01-Mar-93	382.10	NA	NA
02-May-93	365.50	NA	NA
28-May-93	365.50	NA	NA
01-Jul-93	365.50	NA	NA
31-Jul-93	365.50	NA	NA
01-Sep-93	380.19	NA	NA
29-Sep-93	380.18	NA	NA
02-Nov-93	383.13	NA	NA
01-Dec-93	384.10	NA	NA
29-Dec-93	383.50	NA	NA
01-Feb-94	NA	NA	NA
01-Mar-94	383.10	NA	NA
01-Apr-94	385.00	381.7	PI
02-May-94	383.51	380.8	376.2
24-May-94	382.56	381.1	375.6
27-Jun-94	380.05	380.3	374.6
01-Aug-94	379.88	380.2	369.2
01-Sep-94	379.80	380.1	371.4
03-Oct-94	382.18	381.3	375.6
28-Oct-94	382.11	381.6	377.4
02-Dec-94	384.05	380.4	377.4
02-Mar-95	382.78	PI	PI
28-Mar-95	383.84	382.4	377.8
01-May-95	381.76	382.0	374.7
26-May-95	380.96	380.5	374.8
27-Jun-95	379.60	379.9	373.6
26-Jul-95	379.21	381.0	374.3
31-Aug-95	380.02	381.8	373.3
29-Sep-95	380.16	380.0	373.7
07-Nov-95	384.53	384.1	375.8
22-Nov-95	385.66	384.1	375.6
27-Dec-95	383.09	PI	PI
08-Feb-96	384.60	PI	375.4
28-Feb-96	383.60	382.1	375.3
28-Mar-96	384.30	382.0	375.1
30-Apr-96	384.30	372.6	376.9
04-Jun-96	380.57	NA	NA
01-Jul-96	380.00	380.4	374.2
29-Jul-96	380.29	380.2	375.1
28-Aug-96	380.11	380.1	375.2
29-Sep-96	379.91	386.4	375.0
03-Nov-96	383.40	381.8	376.0
29-Nov-96	383.81	382.0	376.1
31-Dec-96	385.42	PI	377.0
31-Mar-97	391.09	PI	PI
30-Apr-97	383.52	382.3	375.4
Average Water level	381.28	381.19	375.10

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
01/31/92	382.70	4.80	1.10	1.34	1.32	1.36	1.24	1.04	1.22
03/03/92	383.00	4.78	1.08	1.30	1.33	1.29	1.22	1.10	1.21
03/12/92	388.96	4.22	1.80	1.57	1.35	1.55	1.97	1.28	1.32
03/13/92	388.73	4.15	1.30	PI	PI	PI	PI	PI	PI
03/14/92	386.90	4.09	PI	PI	PI	PI	PI	PI	PI
03/15/92	384.85	4.21	PI	PI	PI	PI	PI	PI	PI
03/16/92	385.12	4.37	PI	PI	PI	PI	PI	PI	PI
03/17/92	383.50	4.42	PI	PI	PI	PI	PI	PI	PI
03/18/92	382.48	4.58	PI	PI	PI	PI	PI	PI	PI
03/19/92	382.80	4.80	PI	PI	PI	PI	PI	PI	PI
03/20/92	382.60	4.81	PI	PI	PI	PI	PI	PI	PI
04/03/92	384.20	4.50	1.50	1.95	1.90	2.00	1.46	1.25	1.90
04/30/92	380.98	4.42	1.93	2.20	2.09	2.14	2.07	1.86	2.12
06/02/92	384.96	4.52	2.00	2.30	2.25	2.30	2.30	2.10	2.30
07/01/92	380.15	4.90	1.98	2.22	2.12	2.19	2.13	1.91	2.13
08/04/92	380.12	4.93	1.99	2.23	2.15	2.20	2.12	1.92	2.15
09/01/92	380.00	4.95	2.00	2.25	2.15	2.20	2.15	1.95	2.18
09/28/92	380.57	4.77	1.83	2.10	2.00	2.04	1.98	1.77	2.00
10/30/92	382.12	4.93	1.40	1.64	1.56	1.61	1.54	1.37	1.56
11/30/92	384.00	4.43	1.40	1.62	1.54	1.59	1.53	1.32	1.54
12/31/92	384.00	4.68	PF	PF	PF	PF	PF	PF	PF
01/29/93	384.00	4.63	PF	PF	PF	PF		PF	PF
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
03/31/93	393.50	4.12	PF	PF	PF	PF	PF	PF	PF
04/01/93	398.30	4.47	PF	PF	PF	PF	PF	PF	PF
04/02/93	402.50	4.24	PF	PF	PF	PF	PF	PF	PF
04/03/93	402.90	3.99	PF	PF	PF	PF	PF	PF	PF
04/04/93	402.40	3.84	PF	PF	PF	PF	PF	PF	PF
04/05/93	401.20	3.72	PF	PF	PF	PF	PF	PF	PF
04/06/93	400.10	3.68	PF	PF	PF	PF	PF	PF	PF
04/07/93	398.00	3.63	PF	PF	PF	PF	PF	PF	PF
04/08/93	365.50	3.61	PF	PF	PF	PF	PF	PF	PF
04/09/93	365.50	3.62	PF	PF	PF	PF	PF	PF	PF
04/10/93	365.50	3.84	PF	PF	PF	PF	PF	PF	PF
04/11/93	365.50	4.01	1.75	1.60	2.04	1.55	1.50	1.25	1.85
04/12/93	365.50	4.01	1.80	2.10	1.97	2.02	2.02	1.30	1.90
04/13/93	365.50	4.32	1.90	2.15	2.05	2.10	2.05	1.25	1.85
04/14/93	365.50	4.50	1.29	1.91	1.87	1.89	1.99	1.24	1.79
04/15/93	365.50	3.65	1.31	1.74	1.80	1.51	1.93	1.24	1.80
04/16/93	365.50	3.56	1.30	1.71	1.76	1.51	1.80	1.25	1.55
04/17/93	365.50	3.64	1.30	1.79	1.81	1.50	1.90	1.25	1.50
04/18/93	365.50	3.60	1.29	1.67	1.45	1.50	1.85	1.24	1.44
04/19/93	365.50	3.56	1.31	1.55	1.46	1.50	1.89	1.24	1.45
04/20/93	365.50	3.51	1.30	1.55	1.46	1.51	1.80	1.25	1.47
04/21/93	365.50	3.50	1.31	1.56	1.47	1.52	1.80	1.25	1.48
04/22/93	365.50	3.48	1.32	1.57	1.48	1.54	1.80	1.27	1.49
04/23/93	365.50	3.57	1.30	1.55	1.45	1.50	1.75	1.23	1.44
04/24/93	365.50	3.60	1.31	1.55	1.47	1.51	1.44	1.25	1.45

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/25/93	365.50	3.69	1.39	1.64	1.54	1.60	1.52	1.33	1.56
04/26/93	365.50	3.73	1.38	1.62	1.53	1.59	1.52	1.31	1.44
04/27/93	365.50	3.89	1.30	1.55	1.46	1.51	1.44	1.23	1.45
04/28/93	365.50	3.96	1.33	1.58	1.50	1.53	1.47	1.26	1.48
04/29/93	365.50	4.00	1.31	1.56	1.46	1.51	1.44	1.23	1.45
04/30/93	365.50	4.03	1.39	1.63	1.54	1.60	1.53	1.32	1.53
05/01/93	365.50	4.19	1.97	2.20	2.12	2.17	2.11	1.90	2.10
05/02/93	365.50	4.34	1.83	2.08	1.98	2.03	1.97	1.76	1.98
05/28/93	365.50	4.85	1.98	2.23	2.14	2.19	2.12	1.92	2.14
07/01/93	365.50	4.94	1.98	2.22	2.13	2.18	2.12	1.91	2.13
07/31/93	365.50	4.94	1.87	2.11	2.02	2.07	2.01	1.80	2.02
09/01/93	380.19	5.00	1.91	2.15	2.07	2.11	2.05	1.85	2.07
09/29/93	380.18	5.15	1.98	2.22	2.14	2.20	2.10	1.93	2.14
11/02/93	383.13	4.95	1.30	1.55	1.46	1.51	1.45	1.25	1.46
12/01/93	384.10	4.42	1.35	1.60	1.52	1.57	1.50	1.30	1.50
12/29/93	383.50	4.82	PI	PI	PI	PI	PI	PI	PI
02/01/94	NA	NA	NA	NA	NA	NA	NA	NA	NA
03/01/94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	4.36	PI	PI	PI	PI	PI	PI	PI
04/07/94	389.90	4.16	1.42	2.13	2.06	2.06	2.00	1.60	2.00
04/08/94	389.80	3.91	1.42	2.15	2.00	2.04	1.91	1.53	1.91
04/09/94	389.09	3.87	1.40	2.10	2.00	2.00	1.93	1.30	1.90
04/10/94	385.70	3.95	1.50	2.04	2.05	2.08	2.00	1.50	1.82
04/11/94	387.39	4.00	1.40	2.00	2.00	2.15	2.00	1.50	1.95
04/12/94	386.35	4.02	1.40	2.04	1.94	2.02	2.00	1.30	1.82
04/13/94	385.10	4.05	1.50	2.05	2.05	2.05	1.95	1.41	1.95
04/14/94	386.00	4.00	1.40	2.15	2.00	2.10	1.90	1.32	1.85
04/15/94	385.22	3.93	2.10	1.40	1.60	2.10	2.00	2.20	1.45
04/16/94	385.04	3.95	1.41	1.65	1.56	1.61	1.55	1.34	1.55
04/17/94	385.21	3.95	1.39	1.63	1.54	1.60	1.54	1.32	1.54
04/18/94	384.47	4.00	1.46	1.70	1.61	1.66	1.60	1.39	1.60
04/19/94	383.12	4.31	1.49	1.72	1.64	1.69	1.63	1.42	1.63
05/02/94	383.51	4.80	1.80	2.05	1.96	2.01	1.95	1.74	1.96
05/24/94	382.56	4.94	1.96	2.09	2.00	2.05	2.00	1.79	2.00
06/27/94	380.05	5.23	1.97	2.21	2.13	2.17	2.11	1.91	2.13
08/01/94	379.88	5.29	1.99	2.22	2.15	2.18	2.13	1.92	2.17
09/01/94	379.80	5.35	2.00	2.25	2.15	2.20	2.15	1.95	2.16
10/03/94	382.18	5.28	1.40	1.65	1.55	1.60	1.55	1.33	1.56
10/28/94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
12/02/94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
03/02/95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
03/28/95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
05/01/95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
05/26/95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
06/27/95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
07/26/95	379.21	NA	NA	NA	NA	NA	NA	NA	NA
08/31/95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
09/29/95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
10/29/95	389.70	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
10/30/95	388.53	NA	NA	NA	NA	NA	NA	NA	NA
10/31/95	385.80	NA	NA	NA	NA	NA	NA	NA	NA
11/01/95	386.91	NA	NA	NA	NA	NA	NA	NA	NA
11/02/95	383.17	NA	NA	NA	NA	NA	NA	NA	NA
11/03/95	385.81	NA	NA	NA	NA	NA	NA	NA	NA
11/04/95	386.35	NA	NA	NA	NA	NA	NA	NA	NA
11/05/95	385.03	NA	NA	NA	NA	NA	NA	NA	NA
11/06/95	384.85	NA	NA	NA	NA	NA	NA	NA	NA
11/07/95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
11/13/95	388.50	NA	NA	NA	NA	NA	NA	NA	NA
11/14/95	384.91	NA	NA	NA	NA	NA	NA	NA	NA
11/15/95	389.71	NA	NA	NA	NA	NA	NA	NA	NA
11/16/95	390.03	NA	NA	NA	NA	NA	NA	NA	NA
11/17/95	389.65	NA	NA	NA	NA	NA	NA	NA	NA
11/18/95	386.62	NA	NA	NA	NA	NA	NA	NA	NA
11/19/95	384.58	NA	NA	NA	NA	NA	NA	NA	NA
11/20/95	383.30	NA	NA	NA	NA	NA	NA	NA	NA
11/21/95	383.60	NA	NA	NA	NA	NA	NA	NA	NA
11/22/95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
12/27/95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
01/22/96	389.05	NA	NA	NA	NA	NA	NA	NA	NA
01/23/96	388.20	NA	NA	NA	NA	NA	NA	NA	NA
01/24/96	384.67	NA	NA	NA	NA	NA	NA	NA	NA
01/25/96	390.00	NA	NA	NA	NA	NA	NA	NA	NA
01/26/96	388.85	NA	NA	NA	NA	NA	NA	NA	NA
01/27/96	386.67	NA	NA	NA	NA	NA	NA	NA	NA
01/28/96	391.02	NA	NA	NA	NA	NA	NA	NA	NA
01/29/96	393.59	NA	NA	NA	NA	NA	NA	NA	NA
01/30/96	393.86	NA	NA	NA	NA	NA	NA	NA	NA
01/31/96	391.20	NA	NA	NA	NA	NA	NA	NA	NA
02/01/96	386.03	NA	NA	NA	NA	NA	NA	NA	NA
02/02/96	383.94	NA	NA	NA	NA	NA	NA	NA	NA
02/03/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
02/04/96	384.10	NA	NA	NA	NA	NA	NA	NA	NA
02/05/96	384.56	NA	NA	NA	NA	NA	NA	NA	NA
02/06/96	383.90	NA	NA	NA	NA	NA	NA	NA	NA
02/08/96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
02/28/96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
03/28/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04/17/96	395.00	NA	NA	NA	NA	NA	NA	NA	NA
04/18/96	400.10	NA	NA	NA	NA	NA	NA	NA	NA
04/20/96	401.40	NA	NA	NA	NA	NA	NA	NA	NA
04/22/96	397.10	NA	NA	NA	NA	NA	NA	NA	NA
04/23/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/24/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/25/96	389.90	NA	NA	NA	NA	NA	NA	NA	NA
04/26/96	386.40	NA	NA	NA	NA	NA	NA	NA	NA
04/27/96	386.89	NA	NA	NA	NA	NA	NA	NA	NA
04/28/96	384.23	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/29/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
04/30/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
06/04/96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
07/01/96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
07/29/96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
08/28/96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
09/29/96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
10/21/96	392.44	NA	NA	NA	NA	NA	NA	NA	NA
10/22/96	401.65	4.72	1.25	1.50	1.42	1.46	1.40	1.18	1.41
10/23/96	401.80	4.22	1.22	1.47	1.39	1.44	1.37	1.16	1.37
10/24/96	403.17	4.00	1.25	1.47	1.40	1.43	1.37	1.15	1.40
10/25/96	401.36	4.00	1.25	1.50	1.40	1.45	1.38	1.20	1.40
10/26/96	401.00	4.00	1.27	1.51	1.40	1.45	1.40	1.20	1.41
10/27/96	397.60	4.05	NA	NA	NA	NA	NA	NA	NA
10/28/96	393.85	4.10	1.33	1.57	1.49	1.53	1.47	1.37	1.43
10/29/96	386.84	4.23	1.29	1.53	1.46	1.50	1.45	1.43	1.45
10/30/96	383.80	4.52	1.30	1.55	1.46	1.51	1.45	1.23	1.45
10/31/96	383.53	4.54	1.31	1.56	1.47	1.52	1.47	1.24	1.46
11/01/96	383.70	4.83	1.30	1.52	1.46	1.52	1.45	1.23	1.43
11/02/96	384.50	4.80	1.27	1.57	1.42	1.48	1.41	1.20	1.41
11/03/96	383.40	4.96	1.36	1.61	1.51	1.57	1.51	1.30	1.51
11/10/96	389.60	4.51	1.14	1.38	1.30	1.34	1.27	1.06	1.27
11/11/96	386.60	4.25	1.16	1.42	1.33	1.38	1.32	1.12	1.32
11/12/96	386.10	4.17	1.15	1.38	1.30	1.35	1.28	1.10	1.30
11/13/96	383.65	4.35	1.20	1.57	1.38	1.41	1.38	1.15	1.37
11/14/96	383.80	4.36	1.27	1.48	1.42	1.47	1.40	1.20	1.42
11/15/96	384.22	4.40	1.30	1.48	1.45	1.48	1.42	1.25	1.46
11/29/96	383.81	4.82	NA	NA	NA	NA	NA	NA	NA
12/31/96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
03/31/97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
04/21/97	398.04	NA	NA	NA	NA	NA	NA	NA	NA
04/22/97	398.20	NA	NA	NA	NA	NA	NA	NA	NA
04/23/97	397.03	NA	NA	NA	NA	NA	NA	NA	NA
04/24/97	394.28	NA	NA	NA	NA	NA	NA	NA	NA
04/25/97	392.17	NA	NA	NA	NA	NA	NA	NA	NA
04/26/97	385.98	NA	NA	NA	NA	NA	NA	NA	NA
04/27/97	383.05	NA	NA	NA	NA	NA	NA	NA	NA
04/28/97	383.35	NA	NA	NA	NA	NA	NA	NA	NA
04/29/97	385.02	NA	NA	NA	NA	NA	NA	NA	NA
04/30/97	383.52	NA	NA	NA	NA	NA	NA	NA	NA

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PF=Piezometer Frozen
NA=Information not Given

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
01/31/92	382.70	370.9	382.8	382.8	382.6	382.1	382.8	382.9	383.1
03/03/92	382.70	370.9	382.9	382.9	382.5	382.4	382.9	382.7	383.1
03/12/92	388.96	372.8	380.5	382.0	382.5	381.5	380.4	382.1	382.8
03/13/92	388.73	373.0	382.1	PI	PI	PI	PI	PI	PI
03/14/92	386.90	373.2	PI	PI	PI	PI	PI	PI	PI
03/15/92	384.85	372.8	PI	PI	PI	PI	PI	PI	PI
03/16/92	385.12	372.3	PI	PI	PI	PI	PI	PI	PI
03/17/92	383.50	372.1	PI	PI	PI	PI	PI	PI	PI
03/18/92	382.48	371.6	PI	PI	PI	PI	PI	PI	PI
03/19/92	382.80	370.9	PI	PI	PI	PI	PI	PI	PI
03/20/92	382.60	370.8	PI	PI	PI	PI	PI	PI	PI
04/03/92	384.20	371.8	381.5	380.8	380.7	380.0	382.1	382.2	380.9
04/30/92	380.98	372.1	380.1	380.0	380.0	379.6	380.1	380.2	380.1
06/02/92	384.96	371.8	379.8	379.7	379.5	379.1	379.4	379.4	379.6
07/01/92	380.15	370.5	379.9	379.9	379.9	379.4	379.9	380.0	380.1
08/04/92	380.12	370.4	379.9	379.9	379.8	379.4	379.9	380.0	380.0
09/01/92	380.00	370.4	379.8	379.8	379.8	379.4	379.8	379.9	379.9
09/28/92	380.57	370.9	380.4	380.3	380.3	379.9	380.4	380.5	380.5
10/30/92	382.12	370.4	381.8	381.8	381.8	381.3	381.8	381.8	382.0
11/30/92	384.00	372.1	381.8	381.9	381.8	381.4	381.9	382.0	382.0
12/31/92	384.00	371.2	PF	PF	PF	PF	PF	PF	PF
01/29/93	384.00	371.4	PF	PF	PF	PF	386.9	PF	PF
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
03/31/93	393.50	373.1	PF	PF	PF	PF	PF	PF	PF
04/01/93	398.30	371.9	PF	PF	PF	PF	PF	PF	PF
04/02/93	402.50	372.7	PF	PF	PF	PF	PF	PF	PF
04/03/93	402.90	373.5	PF	PF	PF	PF	PF	PF	PF
04/04/93	402.40	374.0	PF	PF	PF	PF	PF	PF	PF
04/05/93	401.20	374.4	PF	PF	PF	PF	PF	PF	PF
04/06/93	400.10	374.5	PF	PF	PF	PF	PF	PF	PF
04/07/93	398.00	374.7	PF	PF	PF	PF	PF	PF	PF
04/08/93	365.50	374.8	PF	PF	PF	PF	PF	PF	PF
04/09/93	365.50	374.7	PF	PF	PF	PF	PF	PF	PF
04/10/93	365.50	374.0	PF	PF	PF	PF	PF	PF	PF
04/11/93	365.50	373.4	380.7	382.0	380.2	381.5	382.0	382.2	381.0
04/12/93	365.50	373.4	380.5	380.3	380.4	380.0	380.3	382.0	380.9
04/13/93	365.50	372.4	380.2	380.1	380.2	379.7	380.2	382.2	381.0
04/14/93	365.50	371.8	382.2	380.9	380.8	380.4	380.4	382.2	381.2
04/15/93	365.50	374.6	382.1	381.5	381.0	381.6	380.6	382.2	381.2
04/16/93	365.50	374.9	382.1	381.6	381.1	381.6	381.0	382.2	382.0
04/17/93	365.50	374.7	382.1	381.3	381.0	381.7	380.7	382.2	382.2
04/18/93	365.50	374.8	382.2	381.7	382.1	381.7	380.8	382.2	382.4
04/19/93	365.50	374.9	382.1	382.1	382.1	381.7	380.7	382.2	382.3
04/20/93	365.50	375.1	382.1	382.1	382.1	381.6	381.0	382.2	382.3
04/21/93	365.50	375.1	382.1	382.1	382.1	381.6	381.0	382.2	382.2
04/22/93	365.50	375.2	382.1	382.0	382.0	381.5	381.0	382.1	382.2
04/23/93	365.50	374.9	382.1	382.1	382.1	381.7	381.2	382.3	382.4

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/24/93	365.50	374.8	382.1	382.1	382.1	381.6	382.2	382.2	382.3
04/25/93	365.50	374.5	381.8	381.8	381.8	381.4	381.9	381.9	382.0
04/26/93	365.50	374.4	381.9	381.9	381.9	381.4	381.9	382.0	382.4
04/27/93	365.50	373.8	382.1	382.1	382.1	381.6	382.2	382.3	382.3
04/28/93	365.50	373.6	382.0	382.0	382.0	381.6	382.1	382.2	382.2
04/29/93	365.50	373.5	382.1	382.1	382.1	381.6	382.2	382.3	382.3
04/30/93	365.50	373.4	381.8	381.9	381.8	381.4	381.9	382.0	382.1
05/01/93	365.50	372.9	379.9	380.0	379.9	379.5	380.0	380.1	380.2
05/02/93	365.50	372.4	380.4	380.4	380.4	379.9	380.4	380.5	380.6
05/28/93	365.50	370.7	379.9	379.9	379.9	379.4	379.9	380.0	380.1
07/01/93	365.50	370.4	379.9	379.9	379.9	379.4	379.9	380.0	380.1
07/31/93	365.50	370.4	380.3	380.3	380.3	379.8	380.3	380.4	380.5
09/01/93	380.19	370.2	380.1	380.1	380.1	379.7	380.2	380.2	380.3
09/29/93	380.18	369.7	379.9	379.9	379.9	379.4	380.0	380.0	380.1
11/02/93	383.13	370.4	382.1	382.1	382.1	381.6	382.1	382.2	382.3
12/01/93	384.10	372.1	382.0	382.0	381.9	381.4	382.0	382.0	382.2
12/29/93	383.50	370.8	PI	PI	PI	PI	PI	PI	PI
02/01/94		NA	NA	NA	NA	NA	NA	NA	NA
03/01/94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	372.3	PI	PI	PI	PI	PI	PI	PI
04/07/94	389.90	373.0	381.7	380.2	380.1	379.8	380.3	381.1	380.5
04/08/94	389.80	373.8	381.7	380.1	380.3	379.9	380.6	381.3	380.8
04/09/94	389.09	373.9	381.8	380.3	380.3	380.0	380.6	382.0	380.9
04/10/94	385.70	373.6	381.5	380.5	380.2	379.8	380.3	381.4	381.1
04/11/94	387.39	373.5	381.8	380.6	380.3	379.5	380.3	381.4	380.7
04/12/94	386.35	373.4	381.8	380.5	380.5	380.0	380.3	382.0	381.1
04/13/94	385.10	373.3	381.5	380.5	380.2	379.9	380.5	381.7	380.7
04/14/94	386.00	373.5	381.8	380.1	380.3	379.7	380.7	382.0	381.0
04/15/94	385.22	373.7	379.5	382.6	381.7	379.7	380.3	379.1	382.3
04/16/94	385.04	373.6	381.8	381.8	381.8	381.3	381.8	381.9	382.0
04/17/94	385.21	373.6	381.8	381.9	381.8	381.4	381.8	382.0	382.0
04/18/94	384.47	373.5	381.6	381.6	381.6	381.2	381.7	381.7	381.9
04/19/94	383.12	372.5	381.5	381.6	381.5	381.1	381.6	381.6	381.8
05/02/94	383.51	370.9	380.5	380.5	380.5	380.0	380.5	380.6	380.7
05/24/94	382.56	370.4	380.0	380.3	380.3	379.9	380.3	380.4	380.5
06/27/94	380.05	369.4	379.9	379.9	379.9	379.5	380.0	380.0	380.1
08/01/94	379.88	369.2	379.9	379.9	379.8	379.4	379.9	380.0	380.0
09/01/94	379.80	369.0	379.8	379.8	379.8	379.4	379.8	379.9	380.0
10/03/94	382.18	369.3	381.8	381.8	381.8	381.4	381.8	381.9	382.0
10/28/94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
12/02/94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
03/02/95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
03/28/95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
05/01/95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
05/26/95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
06/27/95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
07/26/95	379.21	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
08/31/95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
09/29/95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
10/29/95	389.70	NA	NA	NA	NA	NA	NA	NA	NA
10/30/95	388.53	NA	NA	NA	NA	NA	NA	NA	NA
10/31/95	385.80	NA	NA	NA	NA	NA	NA	NA	NA
11/01/95	386.91	NA	NA	NA	NA	NA	NA	NA	NA
11/02/95	383.17	NA	NA	NA	NA	NA	NA	NA	NA
11/03/95	385.81	NA	NA	NA	NA	NA	NA	NA	NA
11/04/95	386.35	NA	NA	NA	NA	NA	NA	NA	NA
11/05/95	385.03	NA	NA	NA	NA	NA	NA	NA	NA
11/06/95	384.85	NA	NA	NA	NA	NA	NA	NA	NA
11/07/95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
11/13/95	388.50	NA	NA	NA	NA	NA	NA	NA	NA
11/14/95	384.91	NA	NA	NA	NA	NA	NA	NA	NA
11/15/95	389.71	NA	NA	NA	NA	NA	NA	NA	NA
11/16/95	390.03	NA	NA	NA	NA	NA	NA	NA	NA
11/17/95	389.65	NA	NA	NA	NA	NA	NA	NA	NA
11/18/95	386.62	NA	NA	NA	NA	NA	NA	NA	NA
11/19/95	384.58	NA	NA	NA	NA	NA	NA	NA	NA
11/20/95	383.30	NA	NA	NA	NA	NA	NA	NA	NA
11/21/95	383.60	NA	NA	NA	NA	NA	NA	NA	NA
11/22/95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
12/27/95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
01/22/96	389.05	NA	NA	NA	NA	NA	NA	NA	NA
01/23/96	388.20	NA	NA	NA	NA	NA	NA	NA	NA
01/24/96	384.67	NA	NA	NA	NA	NA	NA	NA	NA
01/25/96	390.00	NA	NA	NA	NA	NA	NA	NA	NA
01/26/96	388.85	NA	NA	NA	NA	NA	NA	NA	NA
01/27/96	386.67	NA	NA	NA	NA	NA	NA	NA	NA
01/28/96	391.02	NA	NA	NA	NA	NA	NA	NA	NA
01/29/96	393.59	NA	NA	NA	NA	NA	NA	NA	NA
01/30/96	393.86	NA	NA	NA	NA	NA	NA	NA	NA
01/31/96	391.20	NA	NA	NA	NA	NA	NA	NA	NA
02/01/96	386.03	NA	NA	NA	NA	NA	NA	NA	NA
02/02/96	383.94	NA	NA	NA	NA	NA	NA	NA	NA
02/03/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
02/04/96	384.10	NA	NA	NA	NA	NA	NA	NA	NA
02/05/96	384.56	NA	NA	NA	NA	NA	NA	NA	NA
02/06/96	383.90	NA	NA	NA	NA	NA	NA	NA	NA
02/08/96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
02/28/96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
03/28/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04/17/96	395.00	NA	NA	NA	NA	NA	NA	NA	NA
04/18/96	400.10	NA	NA	NA	NA	NA	NA	NA	NA
04/20/96	401.40	NA	NA	NA	NA	NA	NA	NA	NA
04/22/96	397.10	NA	NA	NA	NA	NA	NA	NA	NA
04/23/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/24/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/25/96	389.90	NA	NA	NA	NA	NA	NA	NA	NA
04/26/96	386.40	NA	NA	NA	NA	NA	NA	NA	NA
04/27/96	386.89	NA	NA	NA	NA	NA	NA	NA	NA
04/28/96	384.23	NA	NA	NA	NA	NA	NA	NA	NA
04/29/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
04/30/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
06/04/96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
07/01/96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
07/29/96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
08/28/96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
09/29/96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
10/21/96	392.44	NA	NA	NA	NA	NA	NA	NA	NA
10/22/96	401.65	371.1	382.3	382.3	382.2	381.8	382.3	382.4	382.5
10/23/96	401.80	372.8	382.4	382.4	382.3	381.9	382.4	382.5	382.6
10/24/96	403.17	373.5	382.3	382.4	382.3	381.9	382.4	382.5	382.5
10/25/96	401.36	373.5	382.3	382.3	382.3	381.8	382.4	382.4	382.5
10/26/96	401.00	373.5	382.2	382.2	382.3	381.8	382.3	382.4	382.5
10/27/96	397.60	373.3	NA	NA	NA	NA	NA	NA	NA
10/28/96	393.85	373.1	382.0	382.0	382.0	381.6	382.1	381.8	382.4
10/29/96	386.84	372.7	382.2	382.2	382.1	381.7	382.1	381.6	382.3
10/30/96	383.80	371.8	382.1	382.1	382.1	381.6	382.1	382.3	382.3
10/31/96	383.53	371.7	382.1	382.1	382.1	381.6	382.1	382.2	382.3
11/01/96	383.70	370.8	382.1	382.2	382.1	381.6	382.1	382.3	382.4
11/02/96	384.50	370.9	382.2	382.0	382.2	381.7	382.3	382.4	382.5
11/03/96	383.40	370.3	381.9	381.9	381.9	381.4	381.9	382.0	382.1
11/10/96	389.60	371.8	382.7	382.7	382.6	382.2	382.7	382.8	382.9
11/11/96	386.60	372.7	382.6	382.5	382.5	382.1	382.6	382.6	382.8
11/12/96	386.10	372.9	382.6	382.7	382.6	382.2	382.7	382.7	382.8
11/13/96	383.65	372.3	382.5	382.0	382.4	382.0	382.4	382.5	382.6
11/14/96	383.80	372.3	382.2	382.3	382.2	381.8	382.3	382.4	382.4
11/15/96	384.22	372.2	382.1	382.3	382.1	381.7	382.2	382.2	382.3
11/29/96	383.81	370.8	NA	NA	NA	NA	NA	NA	NA
12/31/96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
03/31/97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
04/21/97	398.04	NA	NA	NA	NA	NA	NA	NA	NA
04/22/97	398.20	NA	NA	NA	NA	NA	NA	NA	NA
04/23/97	397.03	NA	NA	NA	NA	NA	NA	NA	NA
04/24/97	394.28	NA	NA	NA	NA	NA	NA	NA	NA
04/25/97	392.17	NA	NA	NA	NA	NA	NA	NA	NA
04/26/97	385.98	NA	NA	NA	NA	NA	NA	NA	NA
04/27/97	383.05	NA	NA	NA	NA	NA	NA	NA	NA
04/28/97	383.35	NA	NA	NA	NA	NA	NA	NA	NA
04/29/97	385.02	NA	NA	NA	NA	NA	NA	NA	NA
04/30/97	383.52	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8

CODES:

PD= Piezometer Dry
PI=Piezometer Inaccessible
PF=Piezometer Frozen
NA=Information not Given

TABLE 7 - AVERAGE WATER LEVELS FOR EACH RELIEF WELL
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

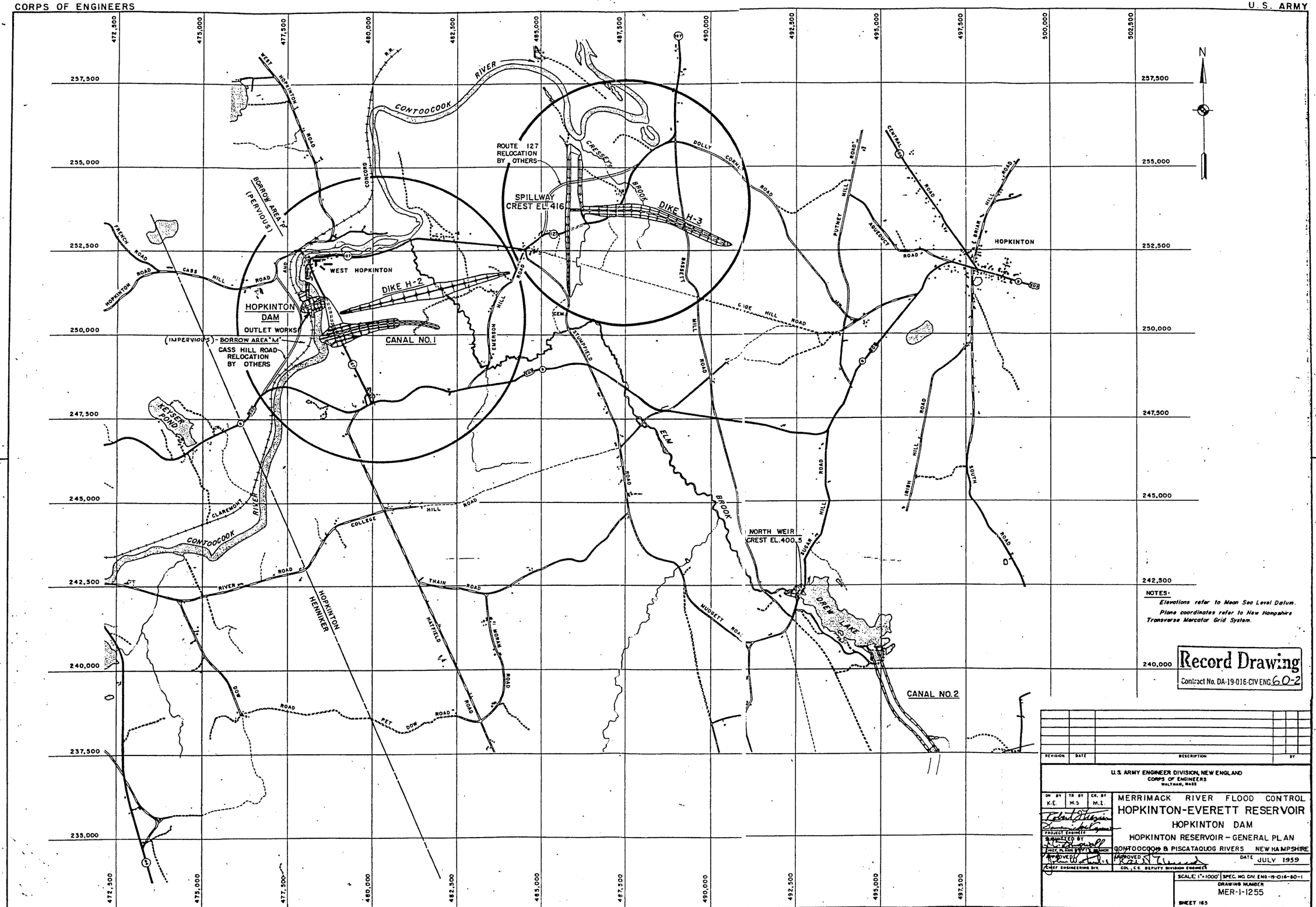
		POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
31-Jan-92	382.70	370.9	382.8	382.8	382.6	382.1	382.8	382.9	383.1
03-Mar-92	382.70	370.9	382.9	382.9	382.5	382.4	382.9	382.7	383.1
03-Apr-92	384.20	371.8	381.5	380.8	380.7	380.0	382.1	382.2	380.9
30-Apr-92	380.98	372.1	380.1	380.0	380.0	379.6	380.1	380.2	380.1
02-Jun-92	384.96	371.8	379.8	379.7	379.5	379.1	379.4	379.4	379.6
01-Jul-92	380.15	370.5	379.9	379.9	379.9	379.4	379.9	380.0	380.1
04-Aug-92	380.12	370.4	379.9	379.9	379.8	379.4	379.9	380.0	380.0
01-Sep-92	380.00	370.4	379.8	379.8	379.8	379.4	379.8	379.9	379.9
28-Sep-92	380.57	370.9	380.4	380.3	380.3	379.9	380.4	380.5	380.5
30-Oct-92	382.12	370.4	381.8	381.8	381.8	381.3	381.8	381.8	382.0
30-Nov-92	384.00	372.1	381.8	381.9	381.8	381.4	381.9	382.0	382.0
31-Dec-92	384.00	371.2	PF	PF	PF	PF	PF	PF	PF
29-Jan-93	384.00	371.4	PF	PF	PF	PF	386.9	PF	PF
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
02-May-93	365.50	372.4	380.4	380.4	380.4	379.9	380.4	380.5	380.6
28-May-93	365.50	370.7	379.9	379.9	379.9	379.4	379.9	380.0	380.1
01-Jul-93	365.50	370.4	379.9	379.9	379.9	379.4	379.9	380.0	380.1
31-Jul-93	365.50	370.4	380.3	380.3	380.3	379.8	380.3	380.4	380.5
01-Sep-93	380.19	370.2	380.1	380.1	380.1	379.7	380.2	380.2	380.3
29-Sep-93	380.18	369.7	379.9	379.9	379.9	379.4	380.0	380.0	380.1
02-Nov-93	383.13	370.4	382.1	382.1	382.1	381.6	382.1	382.2	382.3
01-Dec-93	384.10	372.1	382.0	382.0	381.9	381.4	382.0	382.0	382.2
29-Dec-93	383.50	370.8	PI	PI	PI	PI	PI	PI	PI
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	372.3	PI	PI	PI	PI	PI	PI	PI
02-May-94	383.51	370.9	380.5	380.5	380.5	380.0	380.5	380.6	380.7
24-May-94	382.56	370.4	380.0	380.3	380.3	379.9	380.3	380.4	380.5
27-Jun-94	380.05	369.4	379.9	379.9	379.9	379.5	380.0	380.0	380.1
01-Aug-94	379.88	369.2	379.9	379.9	379.8	379.4	379.9	380.0	380.0
01-Sep-94	379.80	369.0	379.8	379.8	379.8	379.4	379.8	379.9	380.0
03-Oct-94	382.18	369.3	381.8	381.8	381.8	381.4	381.8	381.9	382.0
28-Oct-94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
02-Mar-95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
28-Mar-95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
01-May-95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
26-May-95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
27-Jun-95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
26-Jul-95	379.21	NA	NA	NA	NA	NA	NA	NA	NA
31-Aug-95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
07-Nov-95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
22-Nov-95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
27-Dec-95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
08-Feb-96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
28-Feb-96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
28-Mar-96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
30-Apr-96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04-Jun-96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
01-Jul-96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
29-Jul-96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
28-Aug-96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
03-Nov-96	383.40	370.3	381.9	381.9	381.9	381.4	381.9	382.0	382.1
29-Nov-96	383.81	370.8	NA	NA	NA	NA	NA	NA	NA
31-Dec-96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
30-Apr-97	383.52	NA	NA	NA	NA	NA	NA	NA	NA
Average Water level	381.28	370.76	380.74	380.71	380.68	380.22	381.01	380.84	380.89

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 8 - PREDICTED PIEZOMETER AND RELIEF WELL WATER ELEVATIONS
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

Piezometer	Projected Piezometer Elevation for Reservoir at El. 416
PZ-1	369.4
PZ-2	369.3
PZ-3A	379.2
PZ-3B	379.7
PZ-4A	374.7
PZ-4B	373.3
PZ-5A	372.8
PZ-5B	382.5
PZ-6A	373.0
PZ-6B	382.9
PZ-7A	372.9
PZ-7B	382.9
PZ-8A	372.1
PZ-8B	382.4
PZ-9	369.4
PZ-10	372.6
PZ-11	370.8
PZ-13A	375.3
PZ-13B	NP
PZ-14A	374.2
PZ-14B	382.6
PZ-15	378.1
RW-1	373.8
RW-2	382.4
RW-3	382.6
RW-4	382.6
RW-5	382.2
RW-6	382.7
RW-7	382.6
RW-8	382.7

NOTE
NP = Not predicted due to scatter in data.



NOTES:
Elevations refer to Mean Sea Level Datum.
Plane coordinates refer to New Hampshire Transverse Mercator Grid System.

Record Drawing
Contract No. DA-19-016-CIV ENG. 60-2

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

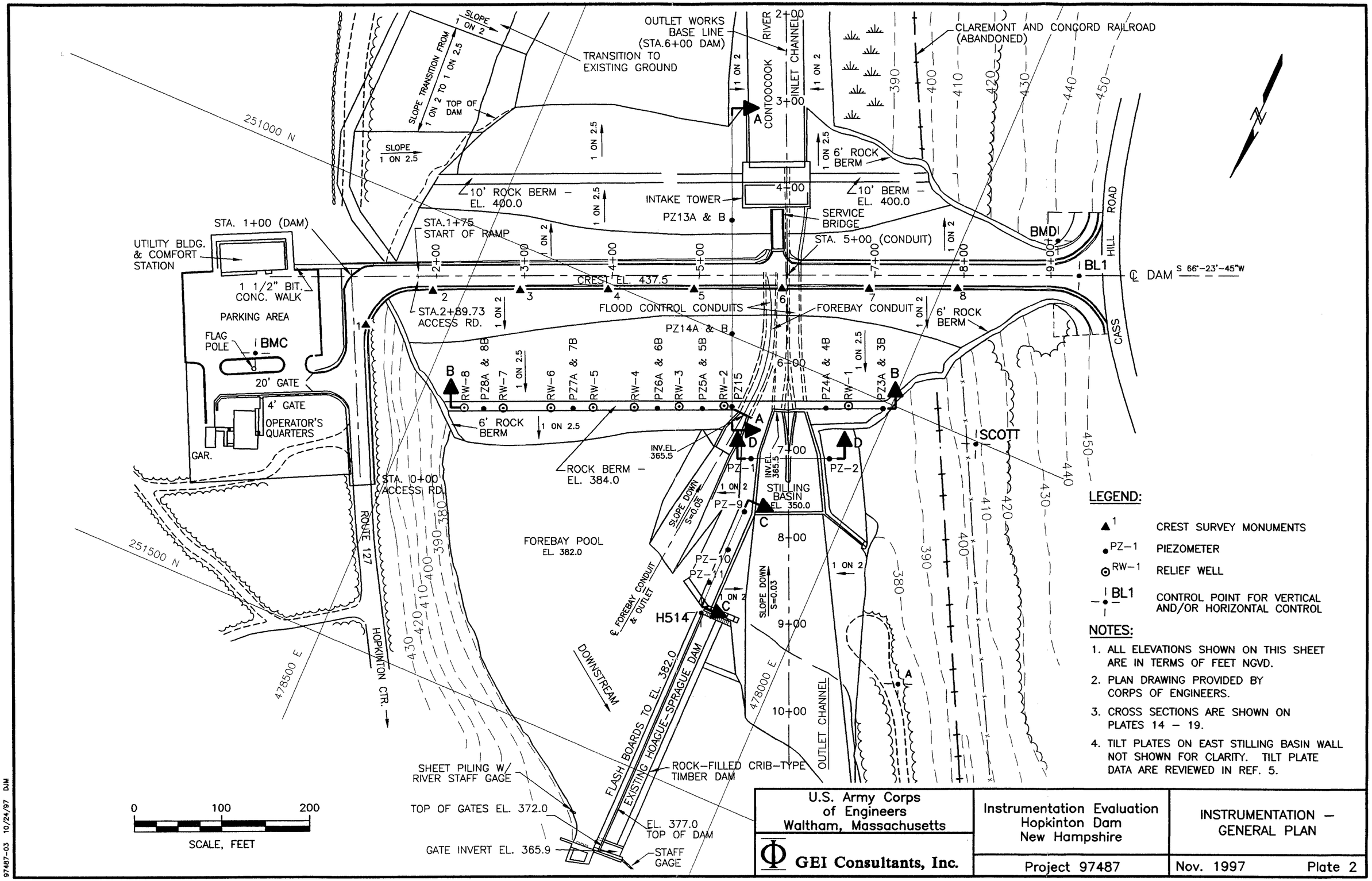
DR. BY	TR. BY	CK. BY
K.E.	M.S.	M.I.

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & REPORTS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
HOPKINTON RESERVOIR – GENERAL PLAN
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959

SCALE: 1" = 1000' | SPEC. NO. CIV. ENG-19-016-60-1
DRAWING NUMBER
MER-1-1255
SHEET 165

PLATE 1


OUTLET WORKS BASE LINE (STA.6+00 DAM)
RIVER
CONTOOCOOK
INLET CHANNEL
CLAREMONT AND CONCORD RAILROAD (ABANDONED)
TRANSITION TO EXISTING GROUND
SLOPE 1 ON 2
SLOPE TRANSITION FROM 1 ON 2 TO 1 ON 2.5
TOP OF DAM
SLOPE 1 ON 2.5
251000 N
1 ON 2.5
1 ON 2
6' ROCK BERM
10' ROCK BERM – EL. 400.0
10' BERM – EL. 400.0
INTAKE TOWER
PZ13A & B
SERVICE BRIDGE
STA. 5+00 (CONDUIT)
STA. 1+00 (DAM)
STA.1+75 START OF RAMP
UTILITY BLDG. & COMFORT STATION
1 1/2" BIT. CONC. WALK
PARKING AREA
FLAG POLE
BMC
20' GATE
4' GATE
OPERATOR'S QUARTERS
GAR.
BMD
BL1
℄ DAM S 66°-23'-45"W
HILL ROAD
CASS
CREST EL. 437.5
FLOOD CONTROL CONDUITS
FOREBAY CONDUIT
STA.2+89.73 ACCESS RD.
PZ14A & B
RW-8
PZ8A & 8B
RW-7
RW-6
PZ7A & 7B
RW-5
RW-4
PZ6A & 6B
RW-3
PZ5A & 5B
RW-2
PZ15
RW-1
PZ4A & 4B
PZ3A & 3B
INV.EL. 365.5
ROCK BERM – EL. 384.0
SCOTT
PZ-1
PZ-2
STILLING BASIN EL. 350.0
PZ-9
PZ-10
PZ-11
SLOPE DOWN S=0.05
SLOPE DOWN S=0.03
STA. 0+00 ACCESS RD.
ROUTE 127
FOREBAY POOL EL. 382.0
251500 N
℄ FOREBAY CONDUIT & OUTLET
H514
DOWNSTREAM
478500 E
478000 E
HOPKINTON CTR.
FLASH BOARDS TO EL. 382.0
EXISTING HOAGUE-SPRAGUE DAM
ROCK-FILLED CRIB-TYPE TIMBER DAM
OUTLET CHANNEL
SHEET PILING W/ RIVER STAFF GAGE
TOP OF GATES EL. 372.0
GATE INVERT EL. 365.9
EL. 377.0 TOP OF DAM
STAFF GAGE
0 100 200
SCALE, FEET
LEGEND:
CREST SURVEY MONUMENTS
PZ-1 PIEZOMETER
RW-1 RELIEF WELL
BL1 CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL
NOTES:
1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. CROSS SECTIONS ARE SHOWN ON PLATES 14 – 19.
4. TILT PLATES ON EAST STILLING BASIN WALL NOT SHOWN FOR CLARITY. TILT PLATE DATA ARE REVIEWED IN REF. 5.
U.S. Army Corps of Engineers Waltham, Massachusetts
GEI Consultants, Inc.
Instrumentation Evaluation Hopkinton Dam New Hampshire
Project 97487
INSTRUMENTATION – GENERAL PLAN
Nov. 1997
Plate 2
97487-03 10/24/97 DJM

CORPS OF ENGINEERS

U. S. ARMY

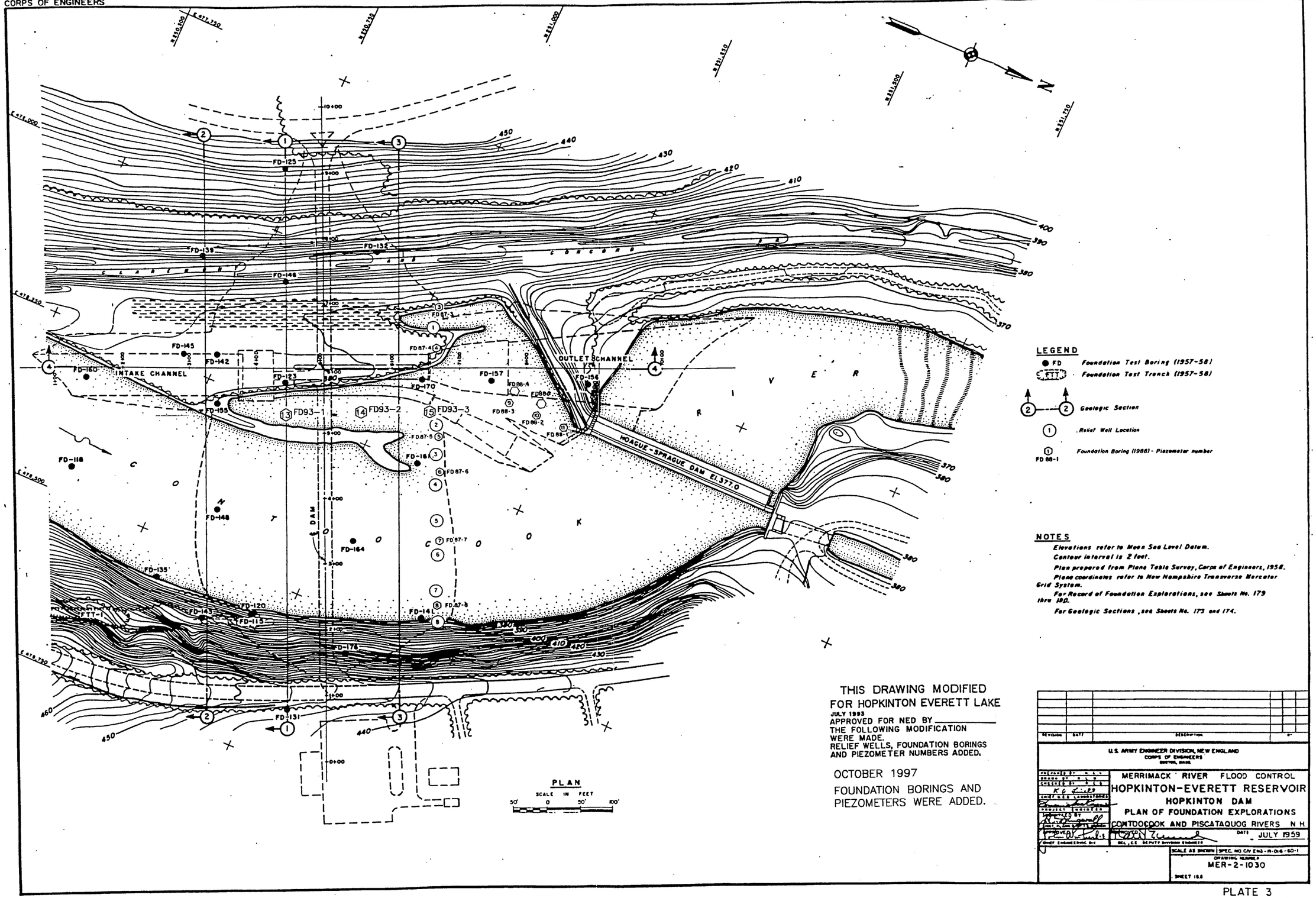
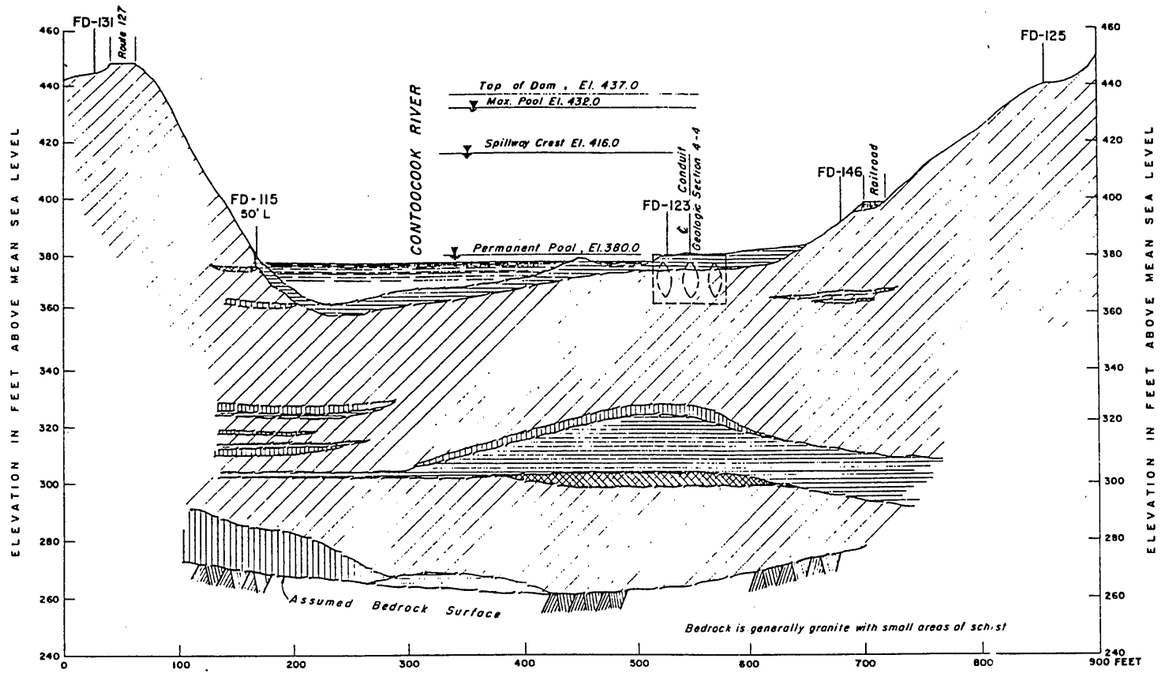
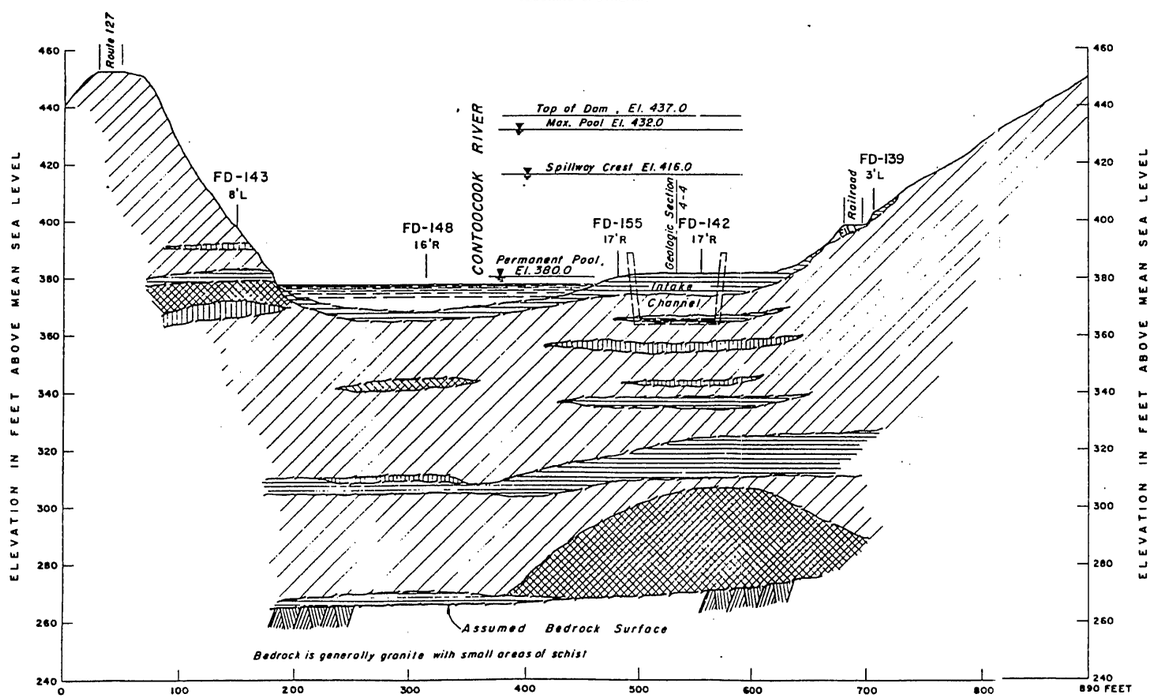


PLATE 3



GEOLOGIC SECTION 1-1, 55' UPSTREAM FROM ℄ DAM
(LOOKING UPSTREAM)



GEOLOGIC SECTION 2-2, 175' UPSTREAM FROM ℄ DAM
(LOOKING UPSTREAM)

LEGEND

- TILL, a hetrogeneous mixture of variable gravelly, silty to clayey SAND with cobbles and boulders.
- Variable gravelly, silty and clayey SAND (TILL) with numerous thin laminae of sand, silt and clay
- Laminated SILT and CLAY
- Variable SAND and GRAVEL, ranging from silty SAND to sandy GRAVEL

Record Drawing
Contract No. D. 19-016-CIV ENG 60-2

NOTES

For Record of Foundation Explorations, see Sheets No. 179 thru 190.

For Location of Geologic Sections, see Sheet No. 168.

This drawing is presented for general information and is to be considered only as a supplement to the records of exploration in other contract drawings. Geologic sections shown hereon are the Government interpretation of subsurface conditions believed to exist at and between borings. Variations between elevations, composition and structure of the individual formations as represented hereon and as actually encountered in the progress of the work are to be anticipated.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

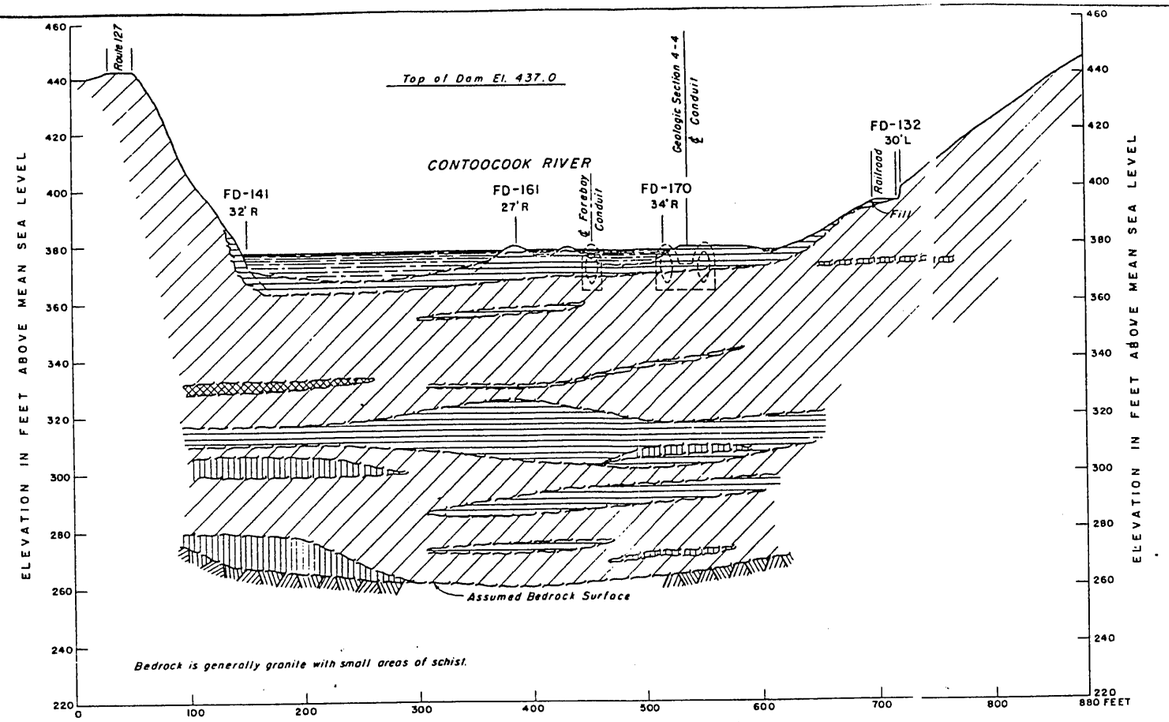
PREPARED BY H. A. V.
DRAWN BY W. K.
CHECKED BY R. C. G.
CHIEF, N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & RPT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
GEOLOGIC SECTIONS 1-1 AND 2-2
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

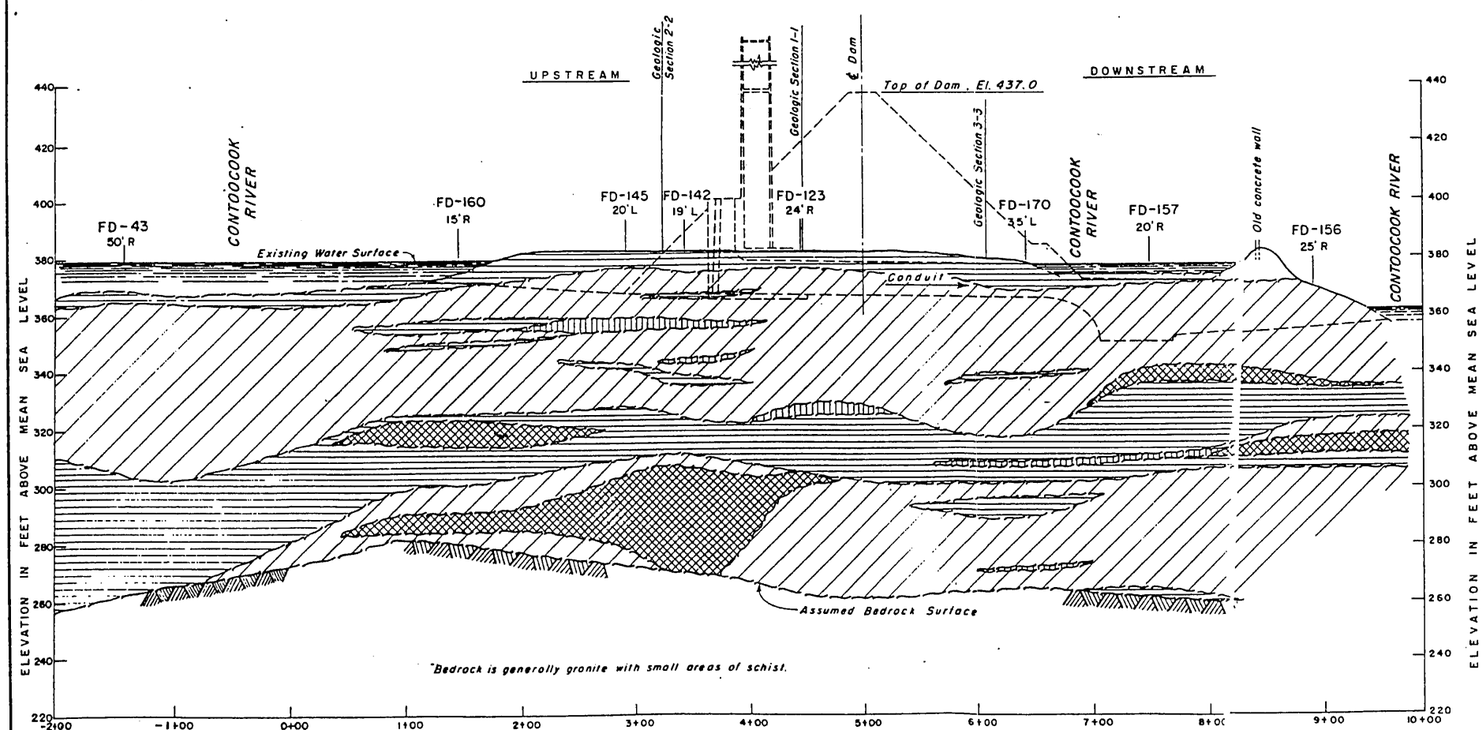
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JUNE 1959

SCALE AS SHOWN | SPEC NO CIV ENG-19-016-60-1
DRAWING NUMBER
MER-2-1036
SHEET 173

PLATE 4A



GEOLOGIC SECTION 3-3, 110' DOWNSTREAM FROM ℄ DAM
(LOOKING UPSTREAM)



GEOLOGIC SECTION 4-4, ALONG ℄ OF CONDUIT
(LOOKING WEST)

LEGEND

- TILL, a hetrogeneous mixture of variable gravelly, silty to clayey SAND with cobbles and boulders.
- Variable gravelly, silty and clayey SAND (TILL) with numerous thin laminae of sand, silt and clay
- Laminated SILT and CLAY
- Variable SAND and GRAVEL, ranging from silty SAND to sandy GRAVEL

Record Drawing
Contract No. DA-11-016-CIV-ENG-60-2

NOTES

For Record of Foundation Explorations, see Sheets No. 179 thru 190.

For Location of Geologic Sections, see Sheet No. 168.

This drawing is presented for general information and is to be considered only as a supplement to the records of exploration in other contract drawings. Geologic sections shown hereon are the Government interpretation of subsurface conditions believed to exist at and between borings. Variations between elevations, composition and structure of the individual formations as represented hereon and as actually encountered in the progress of the work are to be anticipated.

REVISION	DATE	DESCRIPTION	BY

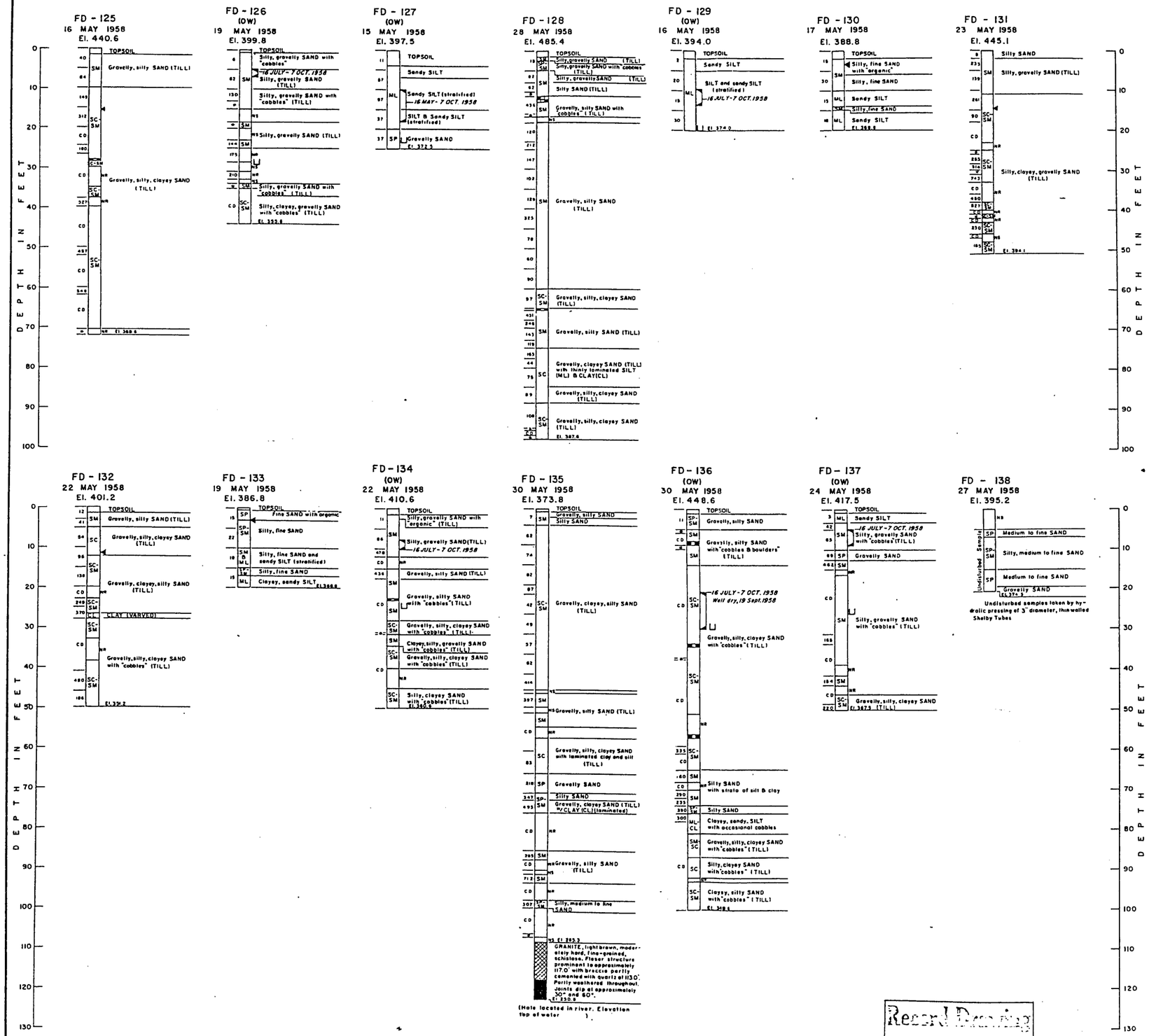
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

PREPARED BY H.A.V.
DRAWN BY W.B.
CHECKED BY R.C.G.
CHIEF N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANS & SPTT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

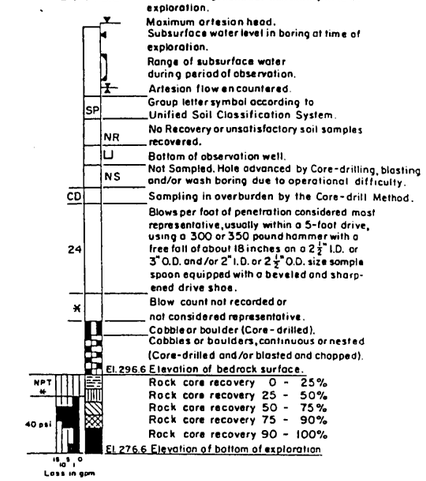
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
GEOLOGIC SECTIONS 3-3 AND 4-4
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

DATE JUNE 1959
SCALE AS SHOWN
SPEC. NO CIV ENG. 19-016-60-1
DRAWING NUMBER
MER-2-1037
SHEET 174

PLATE 4B



LEGEND FOR GRAPHIC LOGS



Foundation Test Boring (1957-58)
Observation well installed.
Date exploration completed.
Elevation of ground surface during time of exploration.
Maximum artesian head.
Subsurface water level in boring at time of exploration.
Range of subsurface water during period of observation.
Artesian flow encountered.
Group letter symbol according to Unified Soil Classification System.
No Recovery or unsatisfactory soil samples recovered.
Bottom of observation well.
Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
Sampling in overburden by the Core-drill Method.
Blows per foot of penetration considered most representative, usually within a 5-foot drive, using a 300 or 350 pound hammer with a free fall of about 18 inches on a $2\frac{1}{2}$" I.D. or 3" O.D. and/or 2" I.D. or $2\frac{1}{2}$" O.D. size sample spoon equipped with a beveled and sharpened drive shoe.
Blow count not recorded or not considered representative.
Cobble or boulder (Core-drilled).
Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped).
El. 296.6 Elevation of bedrock surface.
Rock core recovery 0 - 25%
Rock core recovery 25 - 50%
Rock core recovery 50 - 75%
Rock core recovery 75 - 90%
Rock core recovery 90 - 100%
El. 276.6 Elevation of bottom of exploration

NPT — No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.
40 psi — Constantly maintained pressure for 1 to 5 minutes. Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTE

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-125, FD-131, FD-132 and FD-135, see Sheet No. 168.

Canal No. 1 - FD-126, FD-127, FD-128, FD-129, FD-130, FD-133, FD-134, FD-136 and FD-137, see Sheet No. 169.

Spillway - FD-138, see Sheet No. 171.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

PREPARED BY H. A. V.
DRAWN BY H. C. S.
CHECKED BY A. C. A.
CHIEF, R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANS & RPT'S BRANCH
APPROVED:
CHIEF ENGINEERING DIV.

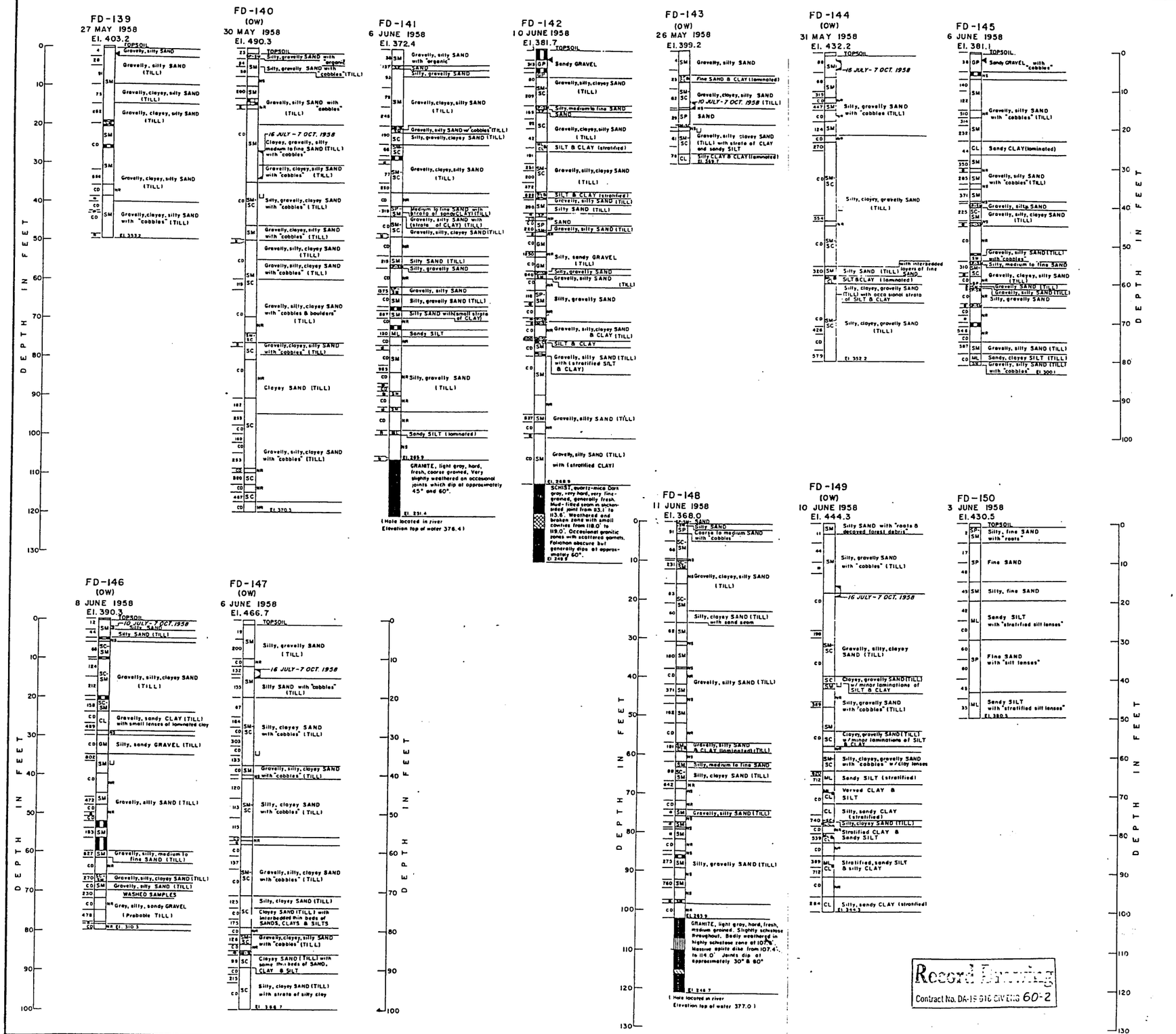
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 7
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959

SCALE AS SHOWN | SPEC NO CIV ENG -19-016-60-1
DRAWING NUMBER
MER-2-1048
SHEET 185

Record Drawing
Contract No DA-1... 60-2

PLATE 5A



LEGEND FOR GRAPHIC LOGS

FD-140	Foundation Test Boring (1957-1958)
(OW)	Observation well installed.
30 MAY 1958	Date exploration completed.
El. 490.3	Elevation of ground surface during time of exploration.
▼	Maximum artesian head.
▼	Subsurface water level boring at time of exploration.
I	Range of subsurface water during period of observation.
▼	Artesian flow encountered.
SP	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
LI	Bottom of observation well.
NS	Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
CD	Sampling in overburden by the Core-drill Method.
24	Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2 1/2" I.D. or 3" O.D. and/or 2" I.D. or 2 1/2" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
*	Blow count not recorded or not considered representative.
	Cobble or boulder (Core-drilled.)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
El. 370.2	Elevation of bedrock surface.
	Rock core recovery 0 – 25%
	Rock core recovery 25 – 50%
	Rock core recovery 50 – 75%
	Rock core recovery 75 – 90%
	Rock core recovery 90 – 100%
El. 276.6	Elevation of bottom of exploration.
NPT	No Pressure Test Performed. Asterisk
*	denotes that section could not be sealed for testing.
40 psi	Constantly maintained pressure for 1 to 5 minutes.
	Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam, FD-139, FD-141, FD-142, FD-143, FD-145, FD-146 and FD-148, see Sheet No. 168.

Canal No. 1, FD-140, FD-144, FD-147 and FD-149, see Sheet No. 169

Dike H-2, FD-150, see Sheet No. 170.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

PREPARED BY
DRAWN BY
CHECKED BY
CHIEF, R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & RPTS. BRANCH
APPROVED: CHIEF ENGINEERING DIV.
APPROVED: COL., C.E. DEPUTY DIVISION ENGINEER

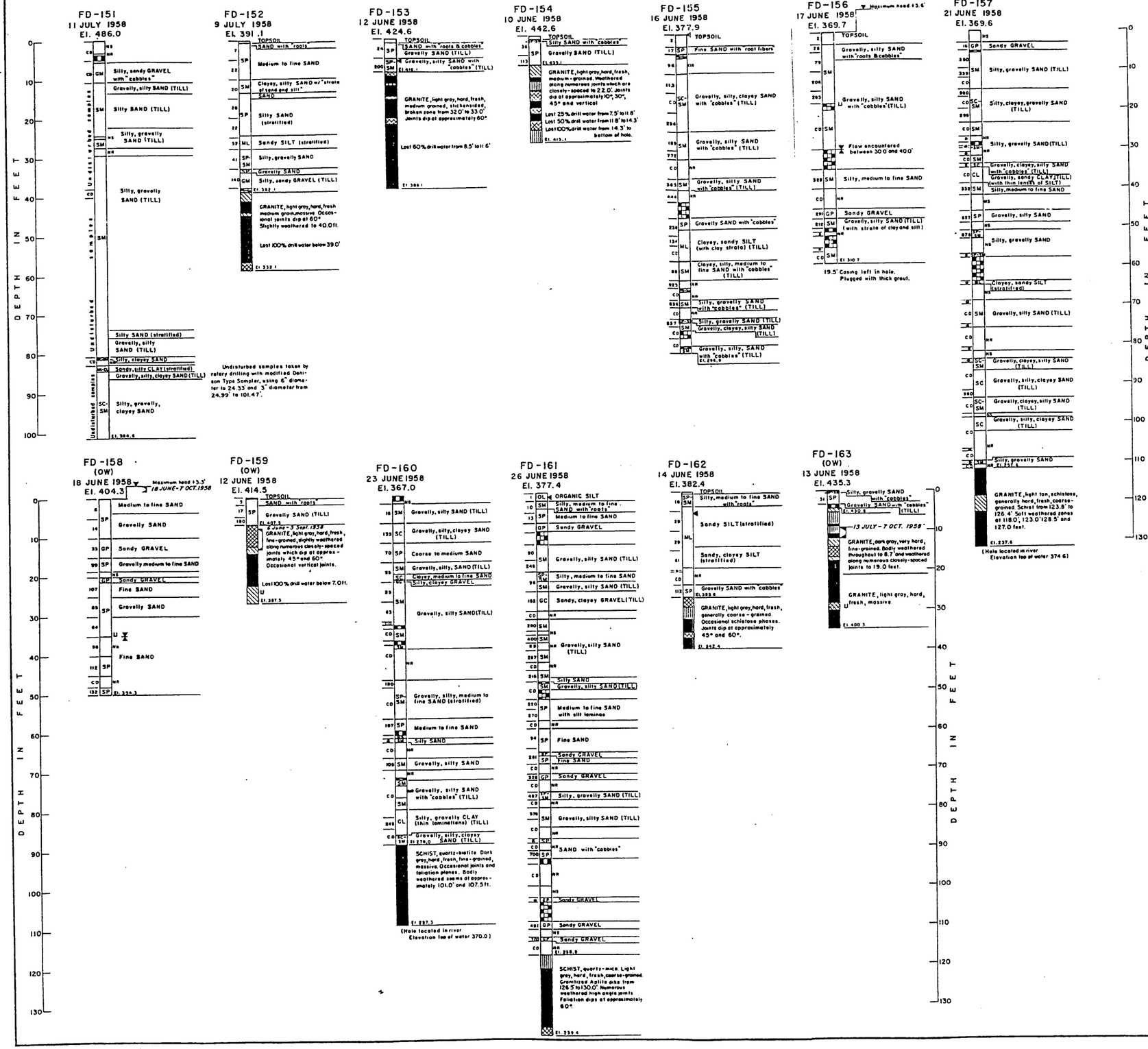
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 8
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

DATE JULY 1959

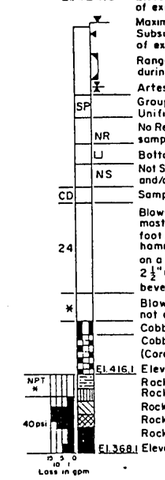
SCALE AS SHOWN | SPEC. NO. CIV ENG-19-016-60-1
DRAWING NUMBER MER-2-1049
SHEET 186

Record Drawing
Contract No. DA-19-016-CIV ENG 60-2

PLATE 5B



LEGEND FOR GRAPHIC LOGS



FD-153	Foundation Test Boring (1957-58)
(OW)	Observation well installed.
12 JUNE 1958	Date exploration completed.
El. 424.6	Elevation of ground surface during time of exploration.
	Maximum artesian head.
	Subsurface water level in boring at time of exploration.
	Range of subsurface water during period of observation.
	Artesian flow encountered.
SP	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
U	Bottom of observation well.
NS	Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
CD	Sampling in overburden by the Core-drill Method.
24	Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2½" I.D. or 3" O.D. and/or 2" I.D. or 2½" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
*	Blow count not recorded or not considered representative.
	Cobble or boulder (Core-drilled.)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
El. 416.1	Elevation of bedrock surface.
NPT *	Rock core recovery 0 - 25 %
	Rock core recovery 25 - 50 %
	Rock core recovery 50 - 75 %
	Rock core recovery 75 - 90 %
	Rock core recovery 90 - 100 %
El. 368.1	Elevation of bottom of exploration.
NPT *	No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.
40 psi	Constantly maintained pressure for 1 to 5 minutes.
	Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions of their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-155, FD-156, FD-157, FD-160 and FD-161, see Sheet No. 168
Canal No. 1 - FD-151, see Sheet No. 169
Dike H-3 - FD-158 and FD-162, see Sheet No. 172
Spillway - FD-152, FD-153, FD-154, FD-159 and FD-163, see Sheet No. 171

Contract No. DA 19 016 ... 60-2

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

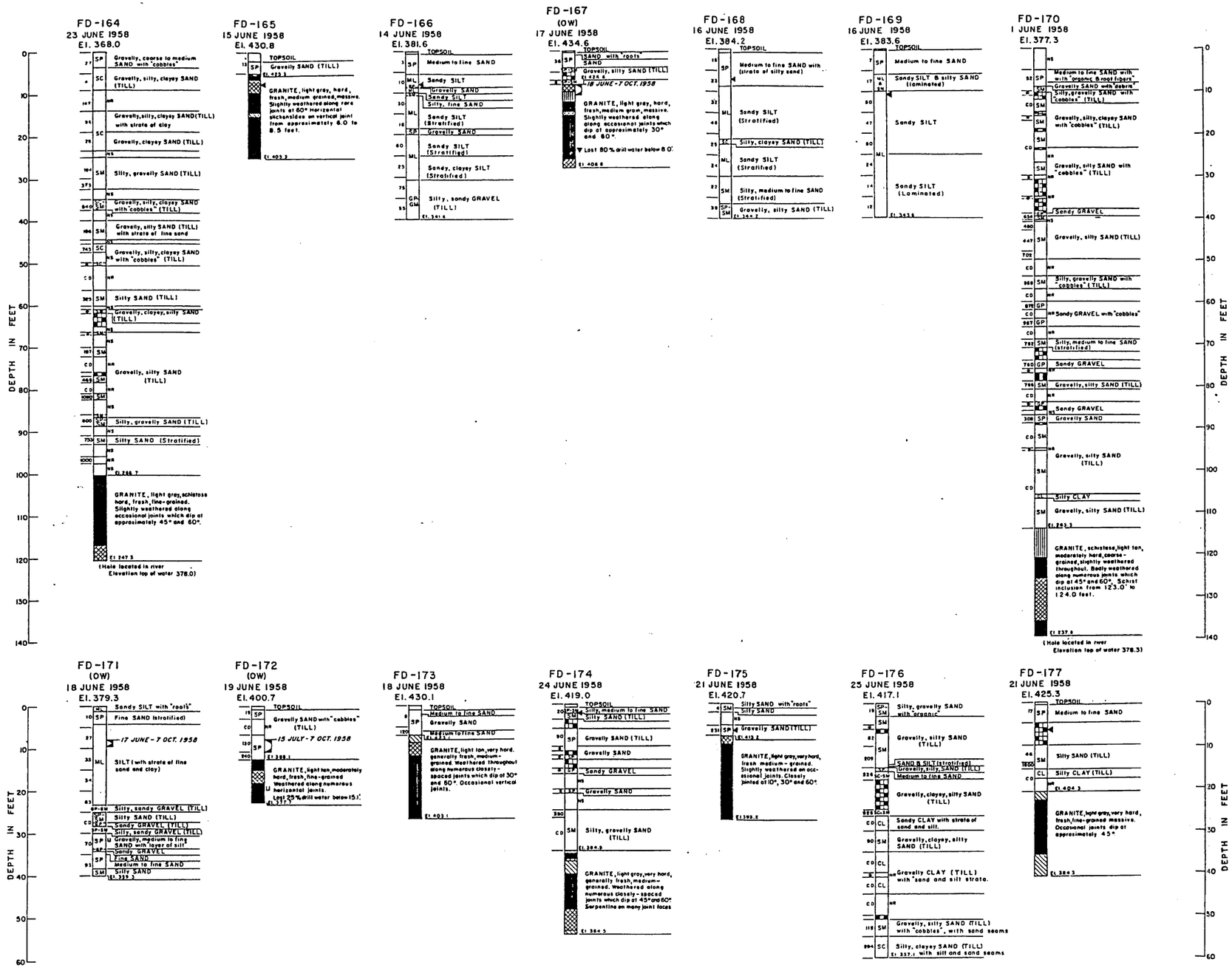
PREPARED BY H. A. Y.
DRAWN BY H. C. S.
CHECKED BY R. C. G.
CHIEF, N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANS & R'PT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 9
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

DATE JULY 1959

SCALE AS SHOWN | SPEC NO CIV ENG-19-016-60-1
DRAWING NUMBER MER-2-1050
SHEET 187

PLATE 5C



LEGEND FOR GRAPHIC LOGS

FD-170	Foundation Test Boring (1957-58)
(OW)	Observation well installed.
1 JUNE 1958	Date exploration completed.
El. 377.3	Elevation of ground surface during time of exploration.
	Maximum artesian head.
	Subsurface water level boring at time of exploration.
	Range of subsurface water during period of observation.
	Artesian flow encountered.
SP	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
LJ	Bottom of observation well.
NS	Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
CD	Sampling in overburden by the Core-drill Method.
24	Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2 1/2" I.D. or 3" O.D. and/or 2" I.D. or 2 1/2" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
*	Blow count not recorded or not considered representative.
	Cobble or boulder (Core-drilled.)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
El. 370.2	Elevation of bedrock surface.
	Rock core recovery 0 - 25 %
	Rock core recovery 25 - 50 %
	Rock core recovery 50 - 75 %
	Rock core recovery 75 - 90 %
	Rock core recovery 90 - 100 %
El. 276.6	Elevation of bottom of exploration.
NPT	No Pressure Test Performed.
*	Asterisk denotes that section could not be sealed for testing.
40 psi	Constantly maintained pressure for 1 to 5 minutes.
	Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-164, FD-170, and FD-176, see Sheet No. 168

Dike H-3 - FD-165, FD-166, FD-168, FD-169, FD-171 and FD-172, see Sheet No. 172

Spillway - FD-167, FD-173, FD-174, FD-175 and FD-177, see Sheet No. 171

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

PREPARED BY H. A. V.
DRAWN BY R. A. W.
CHECKED BY R. C. G.
CHIEF R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & REP. BRANCH
APPROVED
CHIEF ENGINEERING DIV.

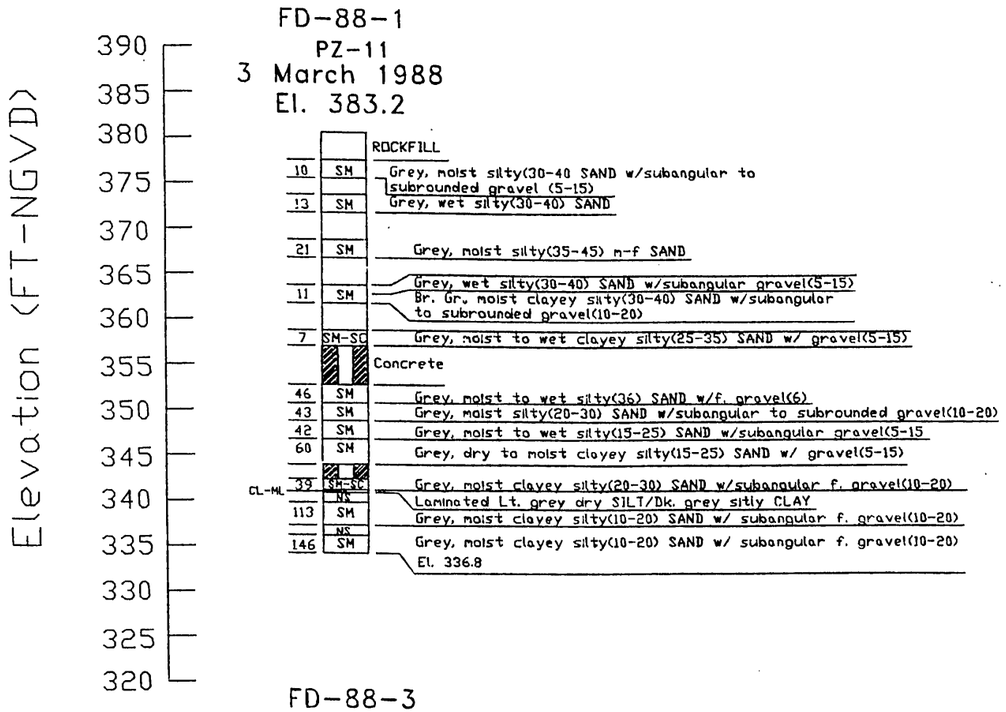
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 10
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

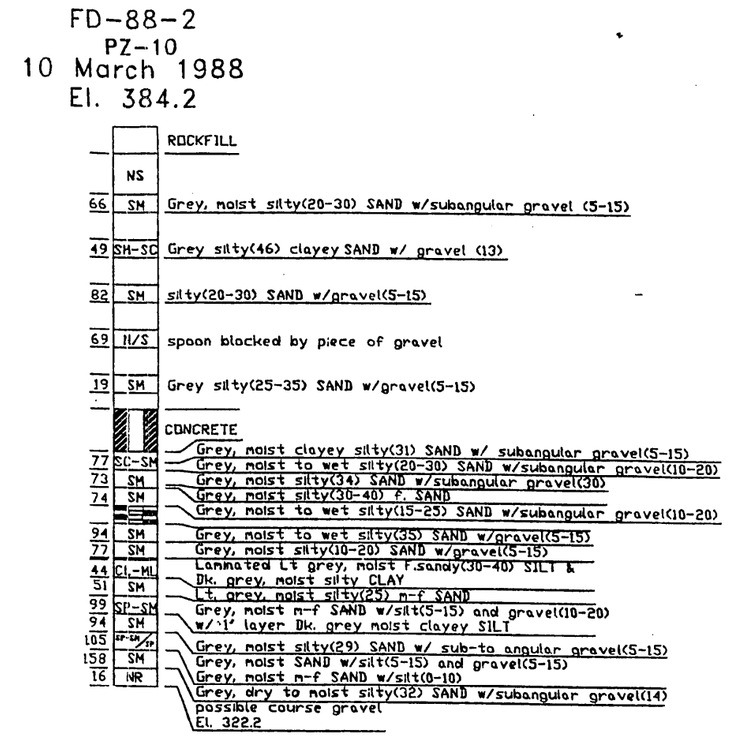
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959

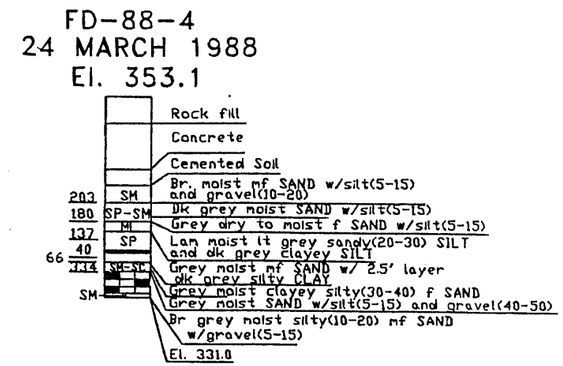
SCALE AS SHOWN | SPEC. NO. CIV ENG.-19-016-60-1
DRAWING NUMBER MER-2-1051
SHEET 188

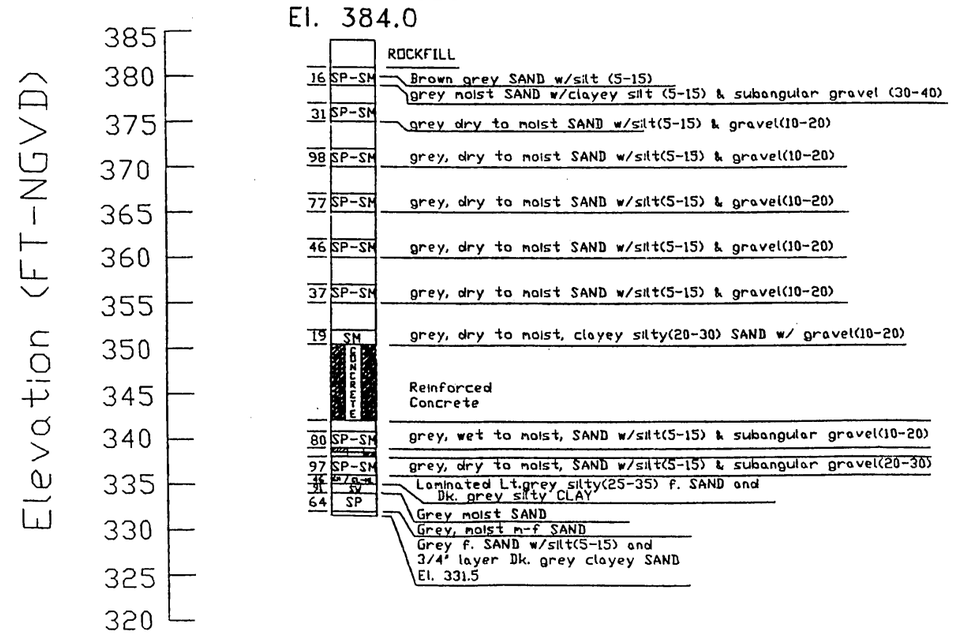
Record Drawing
Contract No. DA-22-079-CIV-ENG-60-2

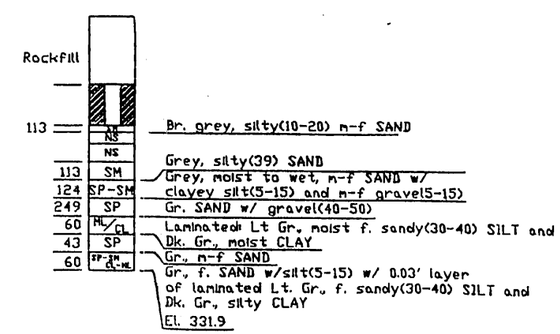
PLATE 5D



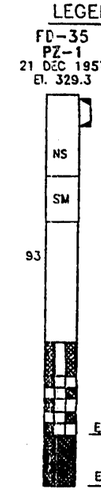








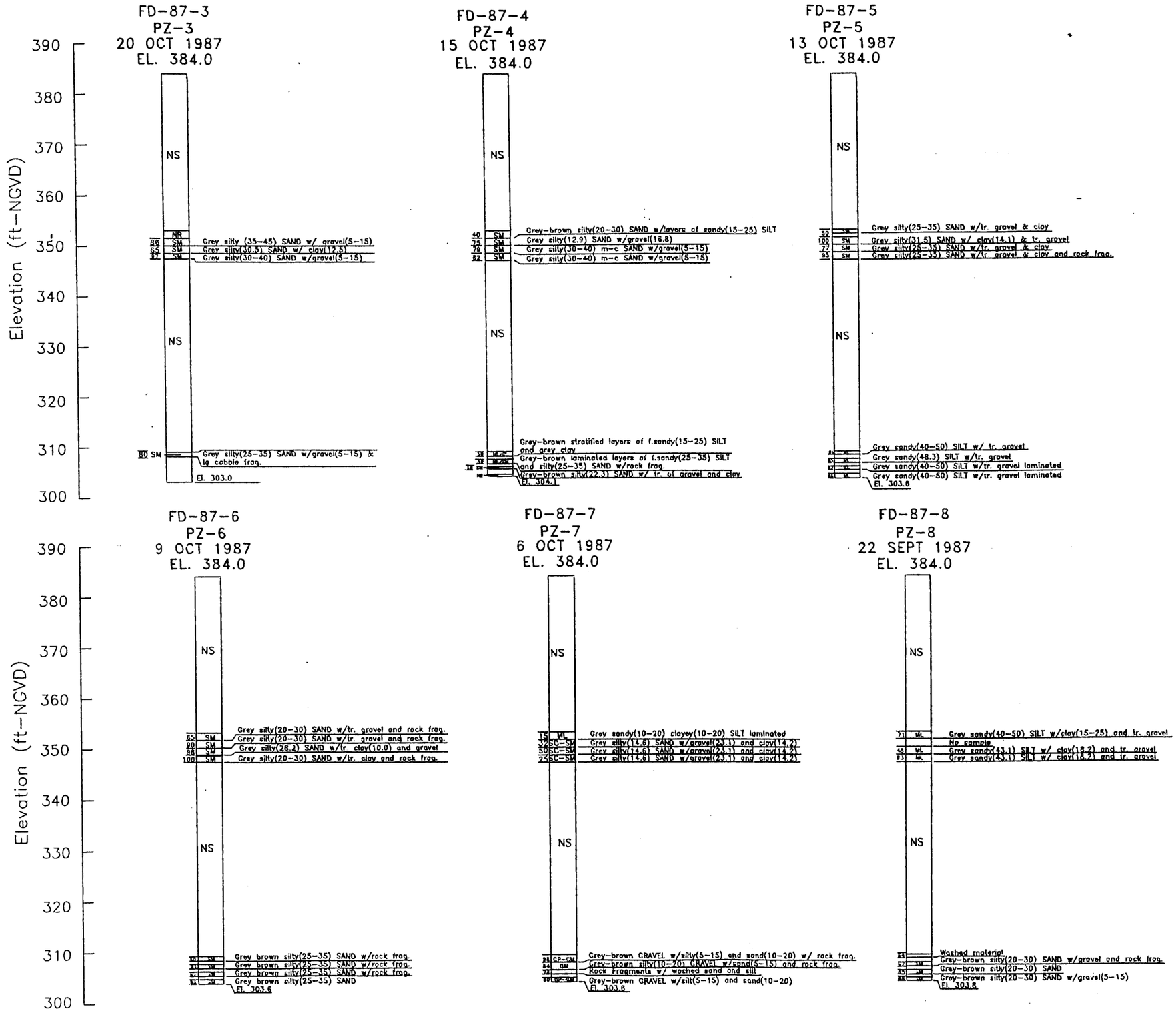
LEGEND FOR GRAPHIC LOGS



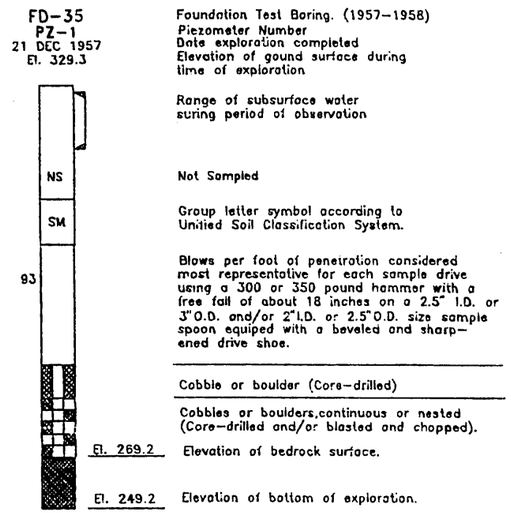
FD-35 — Foundation Test Boring. (1957-1958)
PZ-1 — Piezometer Number
21 DEC 1957 — Date exploration completed
El. 329.3 — Elevation of gound surface during time of exploration
Range of subsurface water suring period of observation
NS — Not Sampled
SM — Group letter symbol according to Unified Soil Classification System.
93 — Blows per foot of penetration considered most representative for each sample drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2.5" I.D. or 3"O.D. and/or 2"I.D. or 2.5"O.D. size sample spoon equiped with a beveled and sharpened drive shoe.
Cobble or boulder (Core-drilled)
Cobbles or boulders,continuous or nested (Core-drilled and/or blasted and chopped).
El. 269.2 — Elevation of bedrock surface.
El. 249.2 — Elevation of bottom of exploration.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD — DESIGN BY	MERRIMACK VALLEY FLOOD CONTROL
MAV — CHECK BY	HOPKINTON DAM
LCD — DRAWN BY	RECORD OF FOUNDATION EXPLORATIONS 1988
GEOTECH. ENG. DIV. PLATE NO. 6	SCALE: AS SHOWN DATE: JULY 1993



LEGEND FOR GRAPHIC LOGS



Foundation Test Boring. (1957-1958)
Piezometer Number
Date exploration completed
Elevation of gound surface during time of exploration

Range of subsurface water during period of observation

Not Sampled

Group letter symbol according to Unified Soil Classification System.

Blows per foot of penetration considered most representative for each sample drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2.5" I.D. or 3" O.D. and/or 2" I.D. or 2.5" O.D. size sample spoon equiped with a beveled and sharpened drive shoe.

Cobble or boulder (Core-drilled)

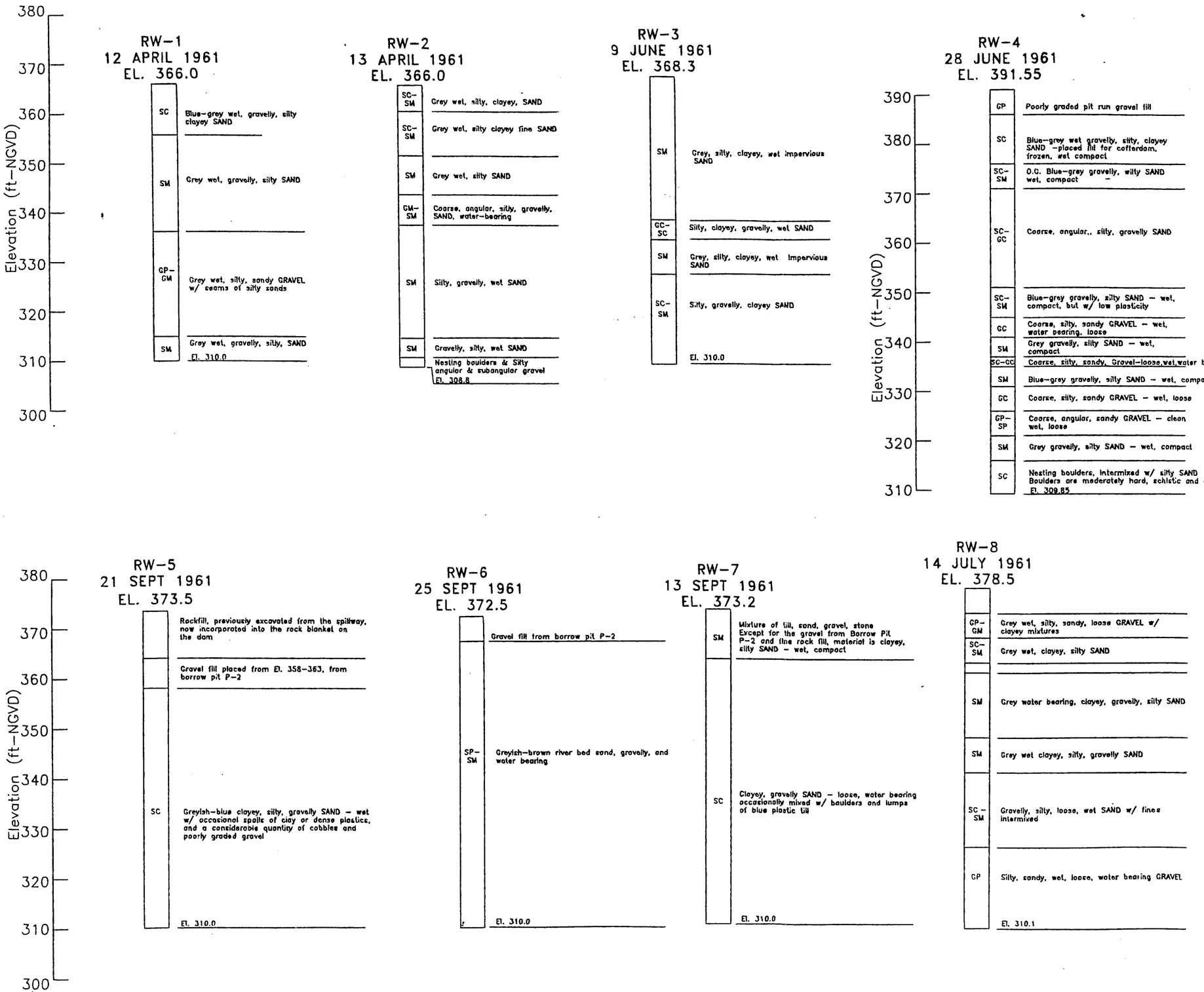
Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped).

Elevation of bedrock surface.

Elevation of bottom of exploration.

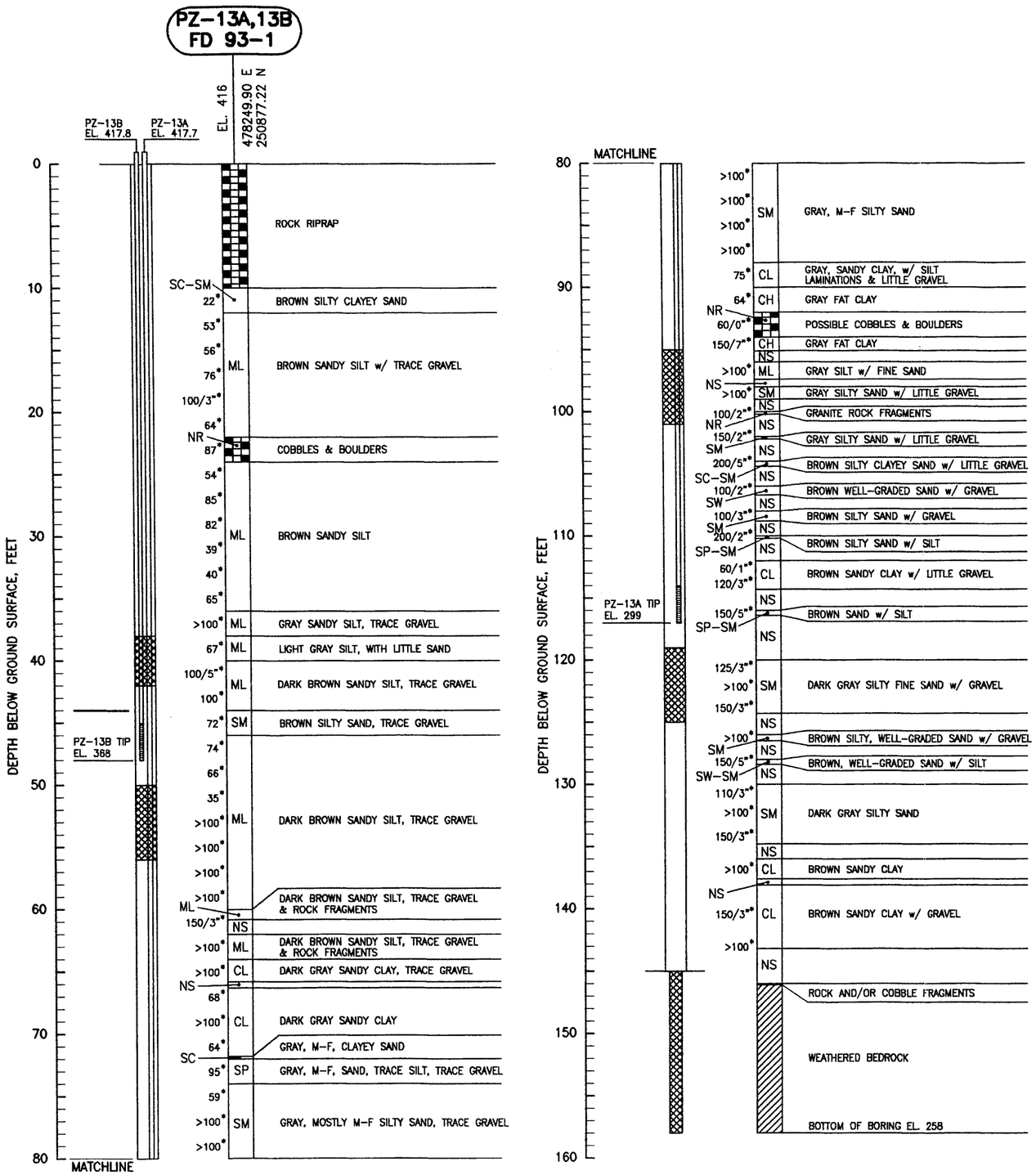
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD DESIGN BY	MERRIMACK VALLEY FLOOD CONTROL HOPKINTON DAM RECORD OF FOUNDATION EXPLORATIONS - PIEZOMETERS 1987
MAV CHECK BY	
LCD DRAWN BY	
GEOTECH. ENG. DIV. PLATE NO. 7	SCALE: AS SHOWN DATE: JULY 1993

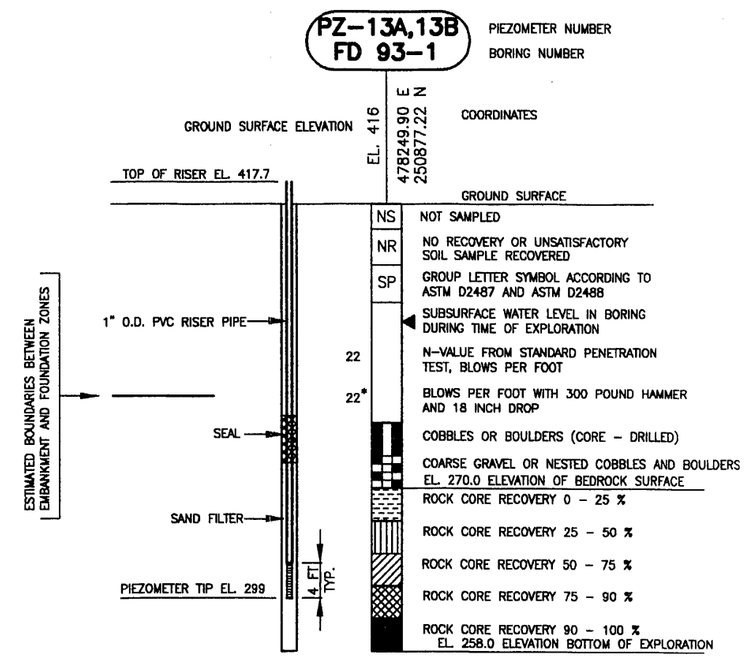


DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD DESIGN BY	MERRIMACK VALLEY FLOOD CONTROL
MAV CHECK BY	HOPKINTON DAM
LCD DRAWN BY	RECORD OF FOUNDATION EXPLORATIONS - RELIEF WELLS
GEOTECH. ENG. DIV. PLATE NO. 8	SCALE: AS SHOWN DATE: JULY 1993



LEGEND FOR GRAPHIC LOG



NOTES:

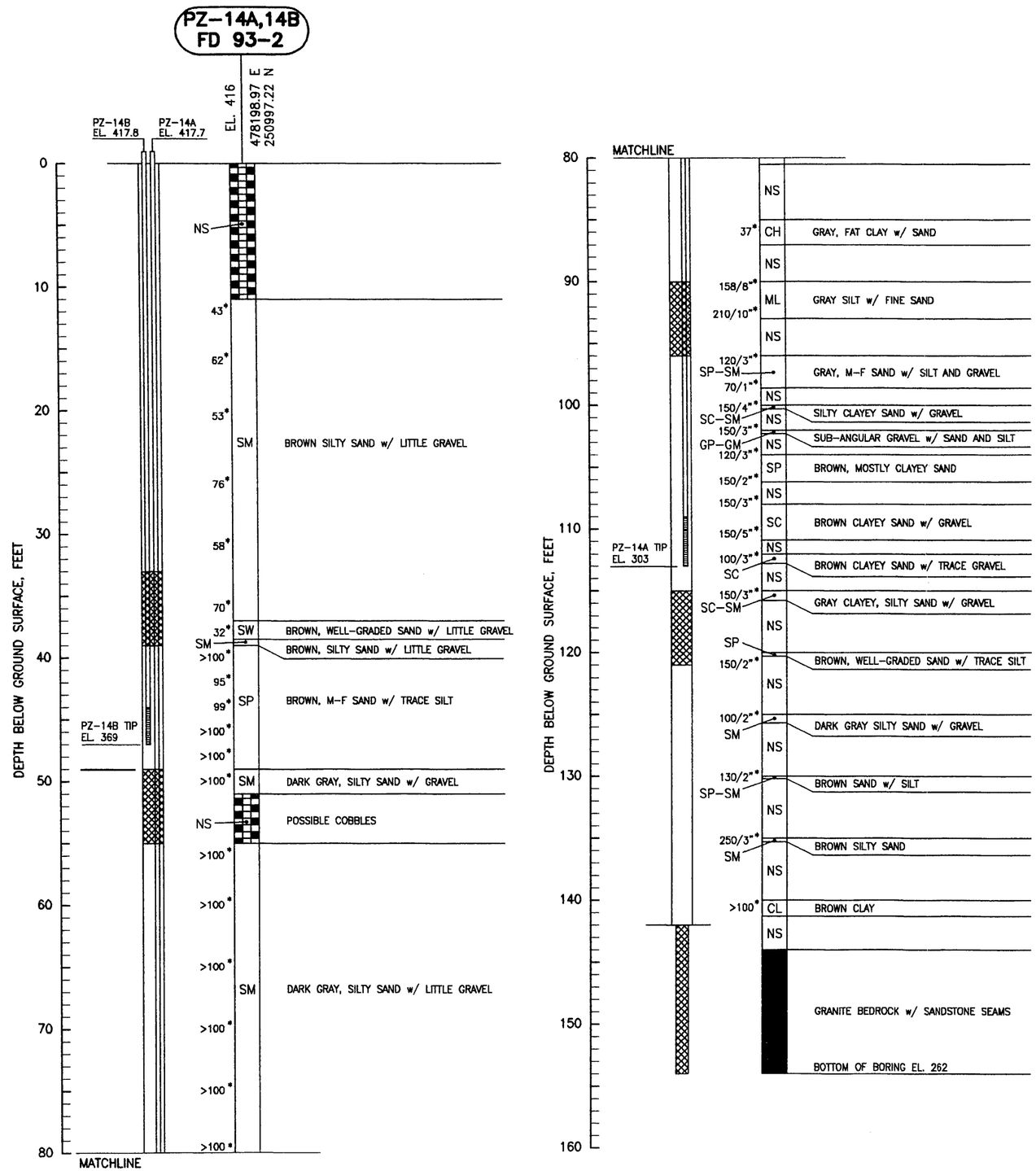
1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.

0 10 20 FEET

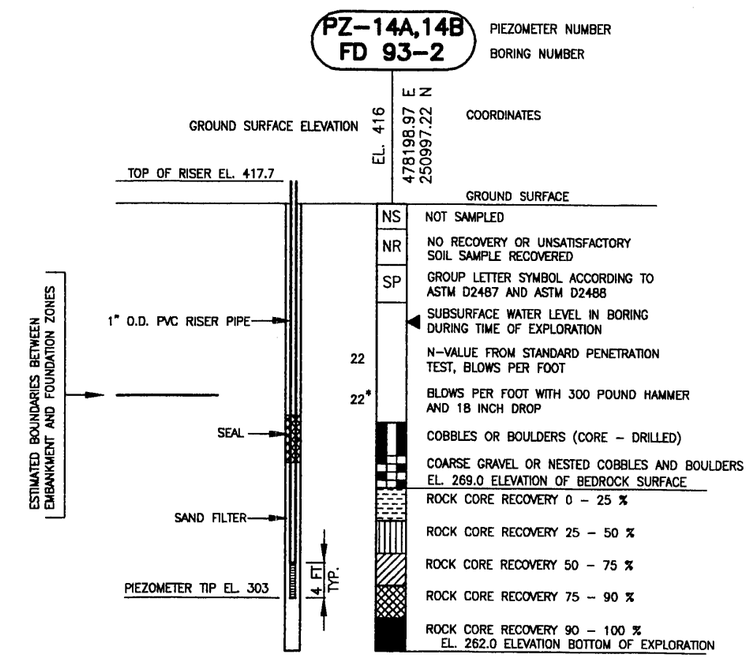
1" = 10'

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-1
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 9

97487-04 11/20/97 DJM



LEGEND FOR GRAPHIC LOG



NOTES:

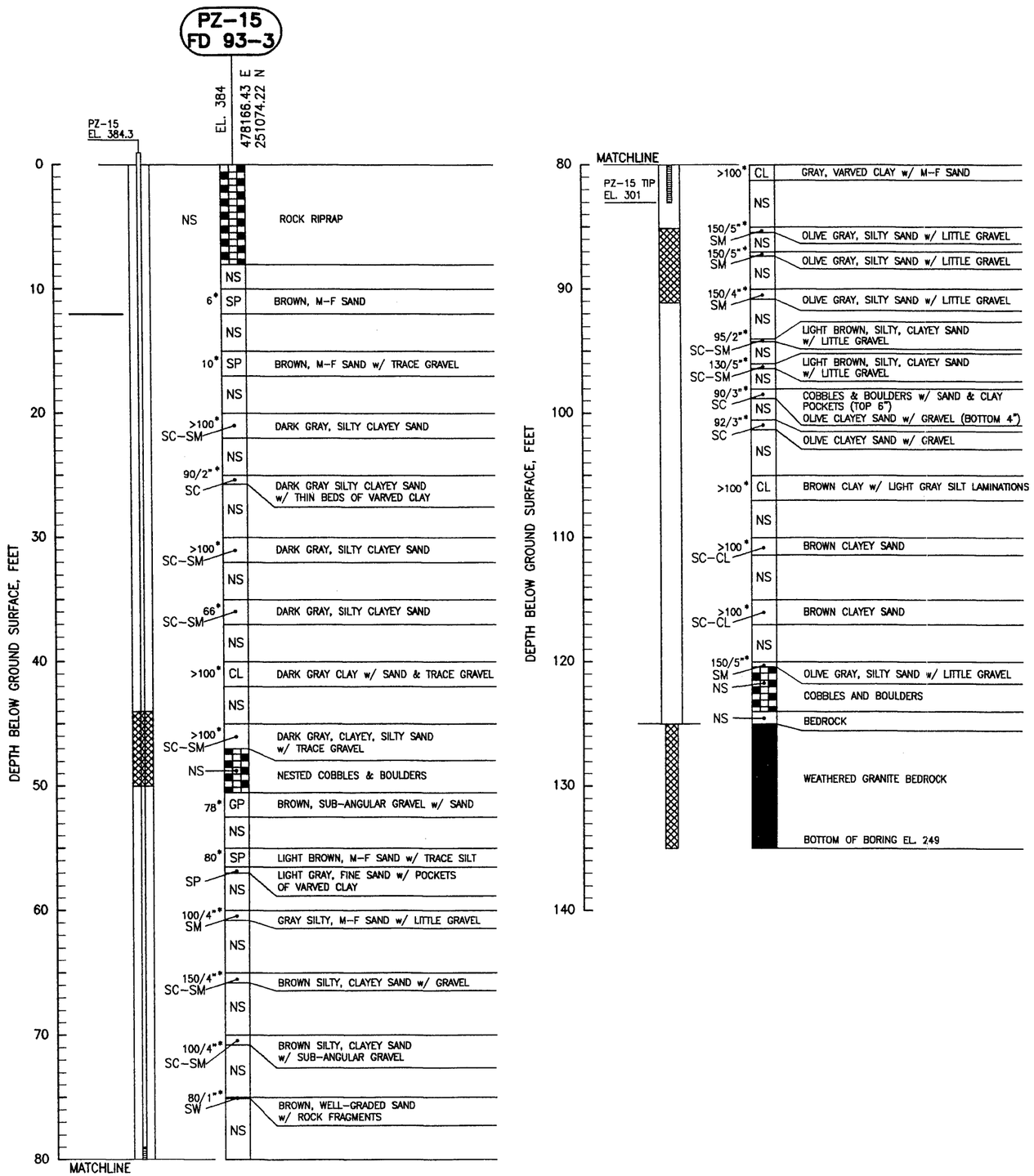
1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.

0 10 20 FEET

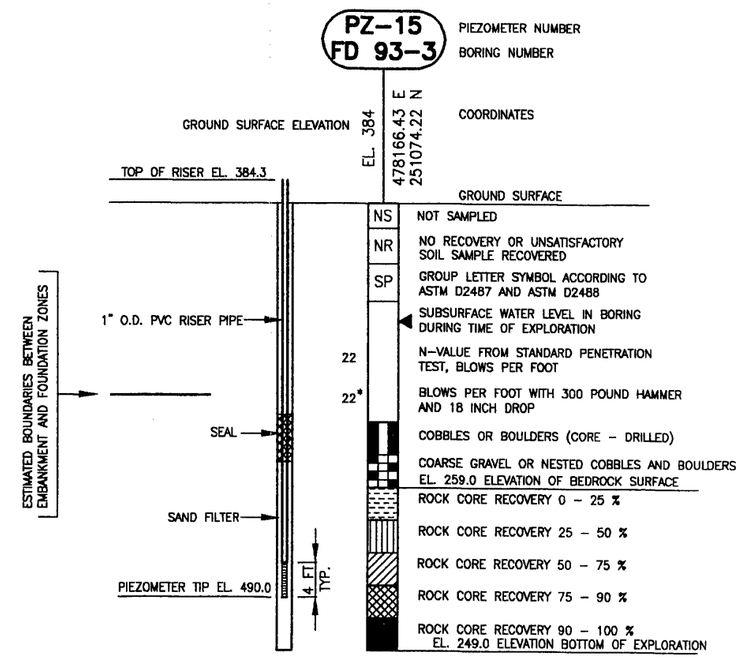
1" = 10'

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-2
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 10

97487-04 11/20/97 DJM

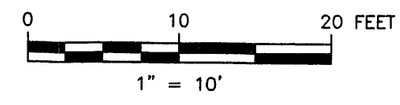


LEGEND FOR GRAPHIC LOG



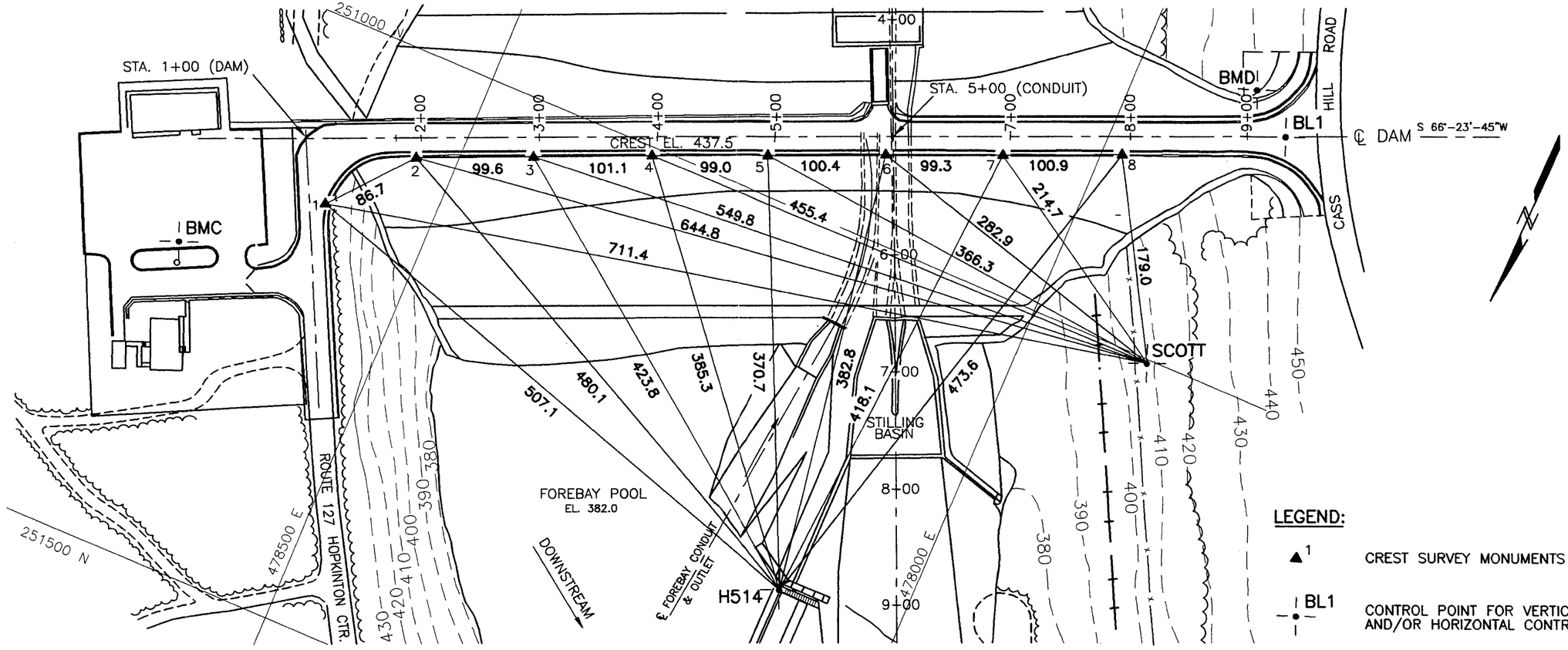
NOTES:

1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.



U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-3
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 11

97487-04 11/20/97 DJM



LEGEND:

▲1 CREST SURVEY MONUMENTS

BL1 CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL

CREST MONUMENT COORDINATE DATA

	SEPTEMBER 1985			MARCH 1986			APRIL 1991			MARCH 1996		
MON.#	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION
1	N/R	N/R	440.975	251153.912	478589.5210	441.016	251153.931	478589.5480	441.058	251153.8947	478589.5397	441.057
2	N/R	N/R	440.590	251087.633	478533.5630	440.636	251087.676	478533.5790	440.670	251087.6544	478533.5795	440.664
3	N/R	N/R	439.660	251047.923	478442.2240	439.695	251047.945	478442.2640	439.729	251047.9249	478442.2695	439.719
4	N/R	N/R	438.135	251007.180	478349.6520	438.157	251007.172	478349.6860	438.198	251007.1779	478349.6942	438.188
5	N/R	N/R	437.710	250967.770	478258.7720	437.731	250967.759	478258.8240	437.782	250967.7658	478258.8316	437.762
6	N/R	N/R	437.840	250927.540	478166.8330	437.869	250927.514	478166.8860	437.910	250927.5253	478166.8962	437.887
7	N/R	N/R	438.480	250888.384	478075.6580	438.492	250888.357	478075.6810	438.539	250888.3538	478075.6906	438.518
8	N/R	N/R	441.300	250847.888	478983.2110	441.312	250847.849	477983.2610	441.352	250847.8451	477983.2733	441.332

CONTROL POINTS COORDINATE DATA

CONTROL POINT	NORTHING	EASTING	ELEVATION
SCOTT	251003.225	477894.302	N/R
H514(B)	251305.341	478105.628	N/R
BMC	N/R	N/R	438.27
BMD	N/R	N/R	440.50
BL1	N/R	N/R	441.27

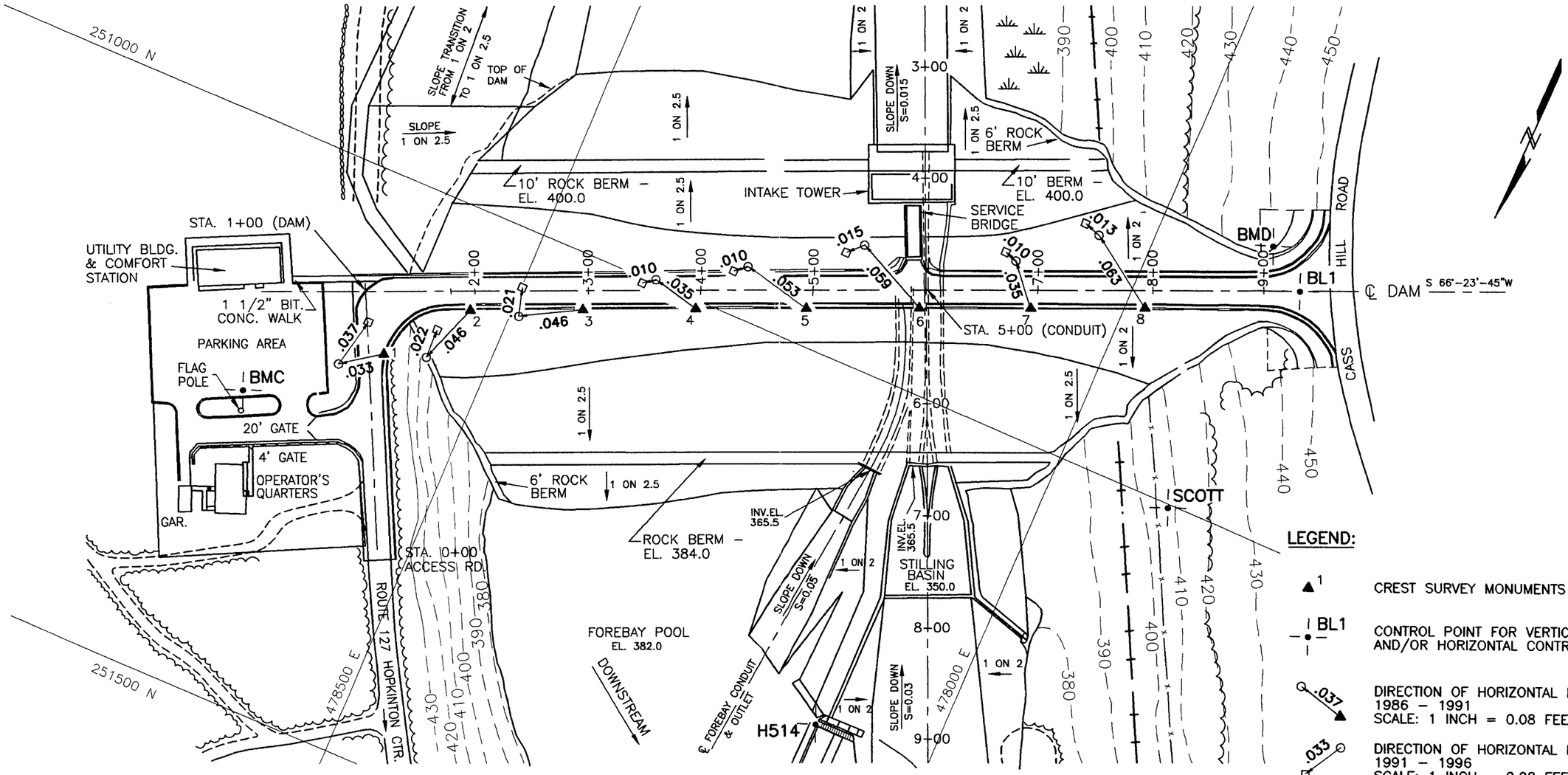
NOTES:

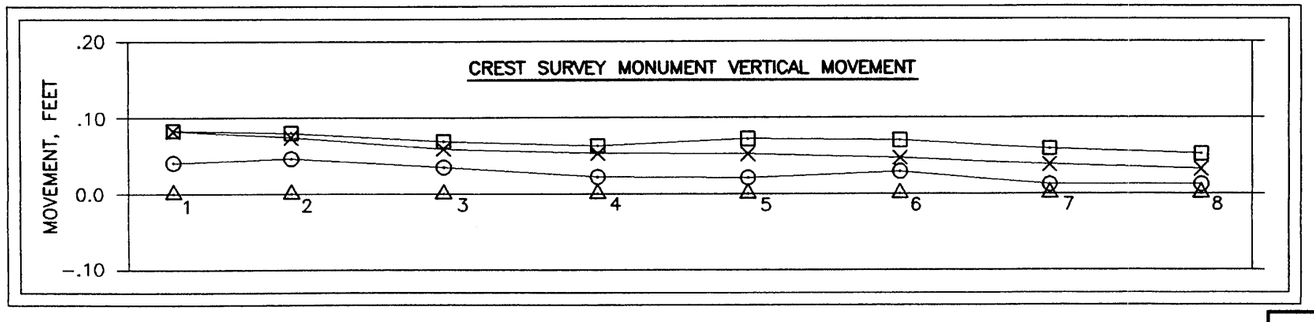
1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. BASE PLAN AND SURVEY DATA PROVIDED BY CORPS OF ENGINEERS.
3. MEASUREMENTS SHOWN ARE FROM MARCH 1996 SURVEY. REFER TO SURVEY BOOK FC 183 AND PLAN-SUR-612 FOR DESCRIPTION AND LOCATION OF CONTROL POINTS. BOOK STORED IN NEDED DESIGN BRANCH, SURVEY UNIT. PLAN STORED IN NEDED, DESIGN BRANCH, CIVIL LAYOUT SECTION.
4. N/R INDICATES INFORMATION NOT RECORDED.
5. ALL DISTANCES SHOWN ARE IN FEET

0 100 200
SCALE, FEET

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	CREST SURVEY MONUMENTS: GENERAL LAYOUT, LOCATION & SURVEY DATA
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 12

97487-11 10/24/97 DJM





LEGEND FOR VERTICAL MOVEMENT	
SYMBOL	DESCRIPTION
△	CREST MONUMENT SURVEY INITIAL ELEVATION SEPT. 1985
⊙	CREST MONUMENT SURVEY MARCH 1986
⊡	CREST MONUMENT SURVEY APRIL 1991
×	CREST MONUMENT SURVEY MARCH 1996

LEGEND:

- ▲1 — CREST SURVEY MONUMENTS
- BL1 — CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL
- .037 — DIRECTION OF HORIZONTAL MOVEMENT 1986 – 1991 SCALE: 1 INCH = 0.08 FEET
- .033 — DIRECTION OF HORIZONTAL MOVEMENT 1991 – 1996 SCALE: 1 INCH = 0.08 FEET

NOTES:

1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.

0 0.08 0.16
HORIZONTAL MOVEMENT SCALE, FEET
1" = 0.08'

0 100 200
PLAN SCALE, FEET
1" = 100'

U.S. Army Corps of Engineers
Waltham, Massachusetts

GEI Consultants, Inc.

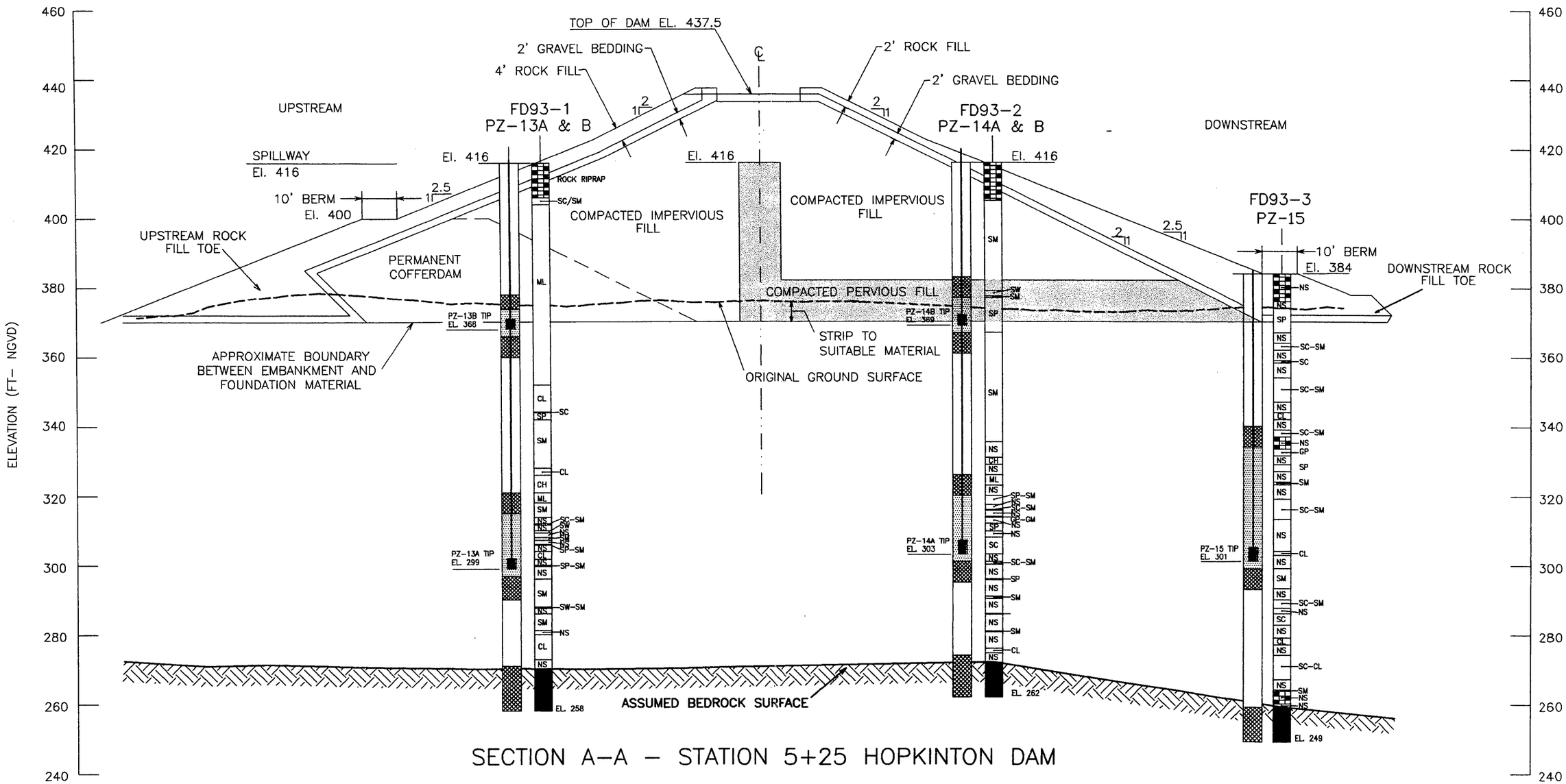
Instrumentation Evaluation
Hopkinton Dam
New Hampshire

Project 97487

CREST SURVEY MONUMENTS: HORIZONTAL & VERTICAL MOVEMENTS

Nov. 1997 Plate 13

97487-12 10/29/97 DJM



SECTION A–A – STATION 5+25 HOPKINTON DAM

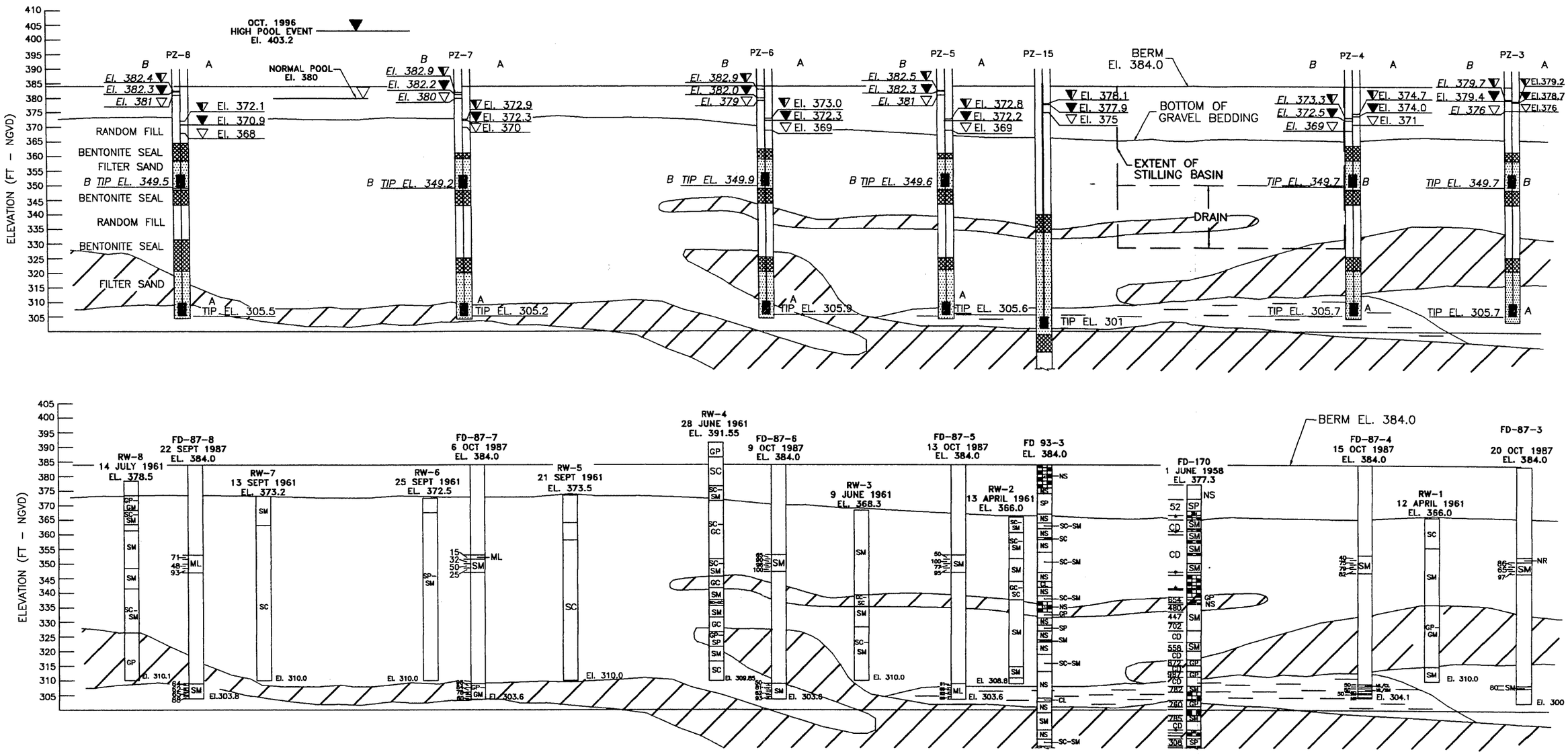
0 30 60
SCALE, FEET

NOTES:

1. ALL ELEVATIONS ARE IN FEET NGVD.
2. SEE PLATES 9 – 11 FOR COMPLETE LOG DETAILS.
3. SECTION BASED ON DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STATION 5+25
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 14

97487-13 11/20/97 DJM



SECTION B–B ALONG DOWNSTREAM BERM

(LOOKING UPSTREAM)

LEGEND:

- POORLY GRADED SANDS AND GRAVELS
- SILTY, CLAYEY SANDS AND GRAVELS, TILL
- STRATIFIED FINE SAND AND SILT
- ▼ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUNDWATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUNDWATER ELEVATION (DATA FROM 1992–1997)

NOTES:

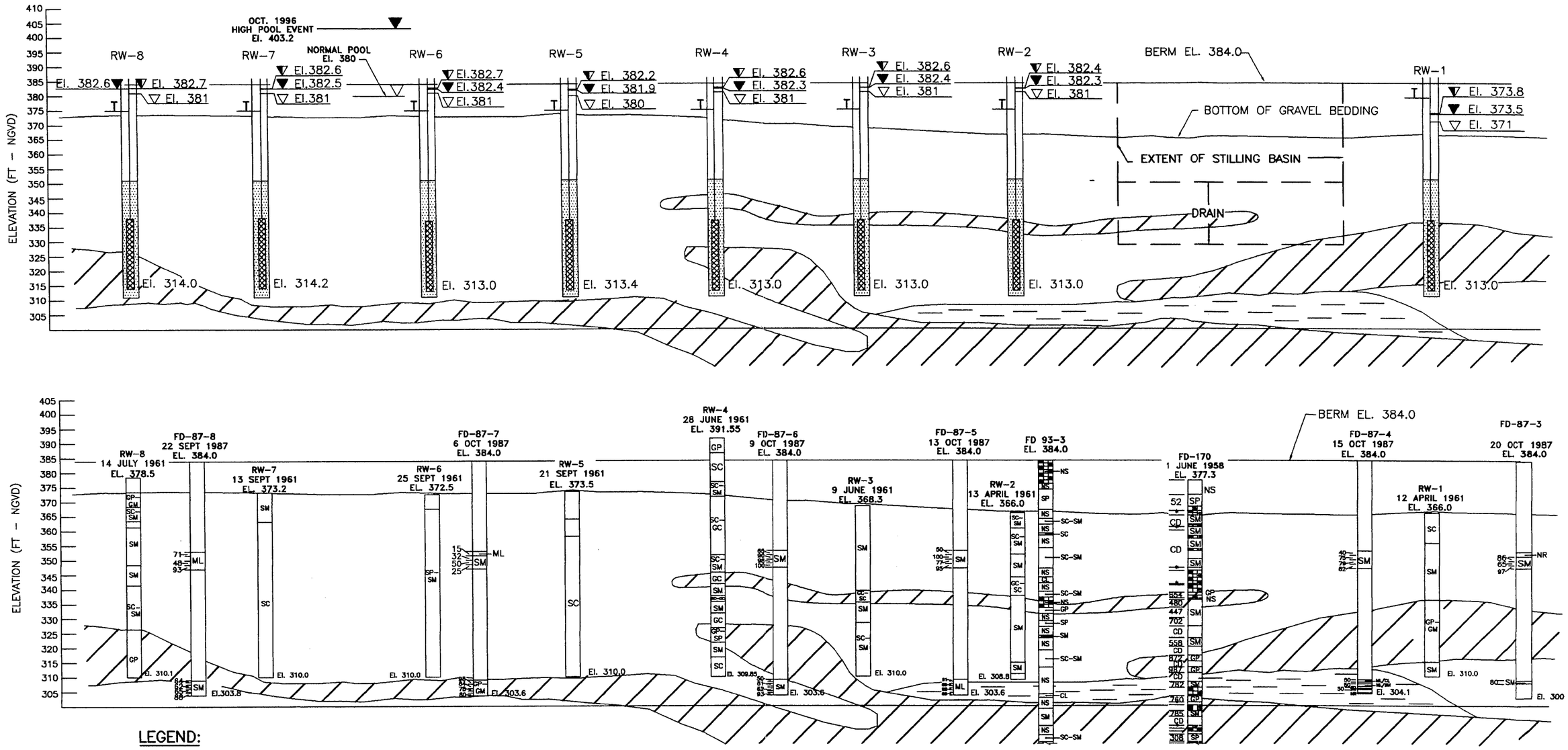
1. SEE PLATES 5A – 11 FOR COMPLETE BORING LOGS
2. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. PIEZOMETER CONSTRUCTION DETAILS SHOWN FOR PZ-8, TYPICAL FOR ALL PIEZOMETERS.

0 35 70

SCALE, FEET

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	DOWNSTREAM BERM PROFILE WITH PIEZOMETRIC PORE WATER LEVELS FROM PIEZOMETERS
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 15

97487-05 11/20/97 DJM



LEGEND:

- POORLY GRADED SANDS AND GRAVELS
- SILTY, CLAYEY SANDS AND GRAVELS, TILL
- STRATIFIED FINE SAND AND SILT
- T — T-OUTLET ELEVATION RW-1 EL. 379 : RW-2-8 EL. 375
- ▼ PROJECTED RELIEF WELL READINGS
- ▼ MAXIMUM RELIEF WELL READING TO DATE DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL RELIEF WELL READING (DATA FROM 1992–1997)

SECTION B–B ALONG DOWNSTREAM BERM

(LOOKING UPSTREAM)

0 35 70

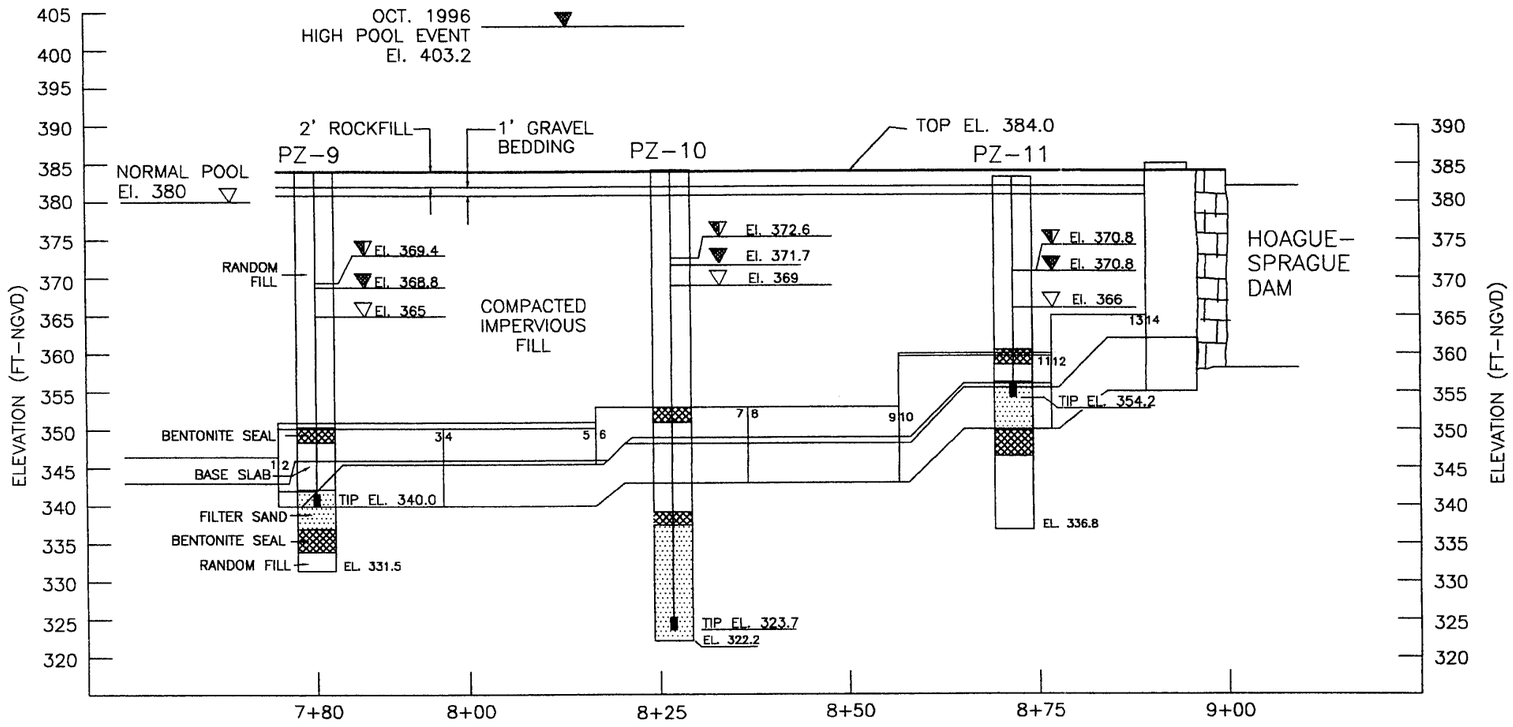
SCALE, FEET

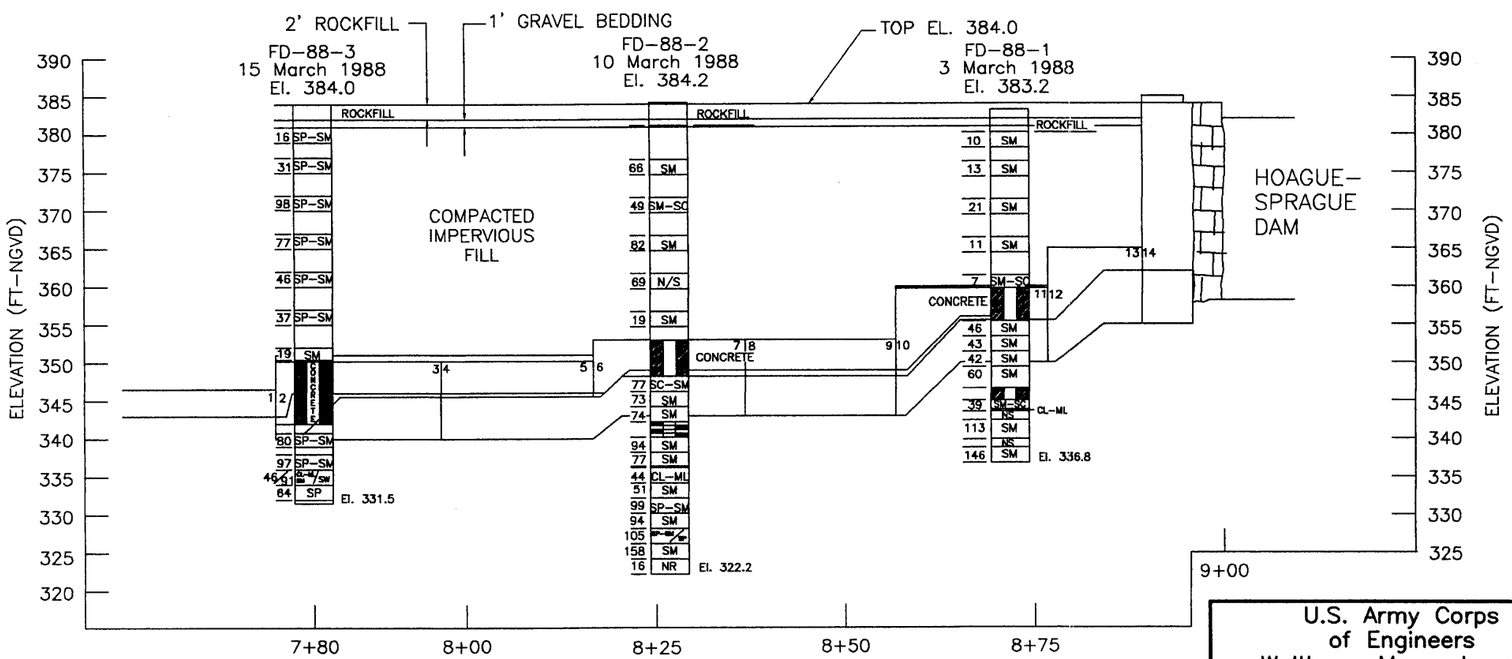
NOTES:

1. SEE PLATE 25 FOR RELIEF WELL DETAILS
2. SEE PLATES 5A – 11 FOR COMPLETE BORING LOGS
3. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	DOWNSTREAM BERM PROFILE WITH PIEZOMETRIC PORE WATER LEVELS FROM RELIEF WELLS
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 16

97487-06 11/20/97 DJM





SECTION C-C ALONG EAST OUTLET CHANNEL WALL
(LOOKING TOWARDS LEFT ABUTMENT)

LEGEND:

- ▼ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUNDWATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUNDWATER ELEVATION (DATA FROM 1992-1997)

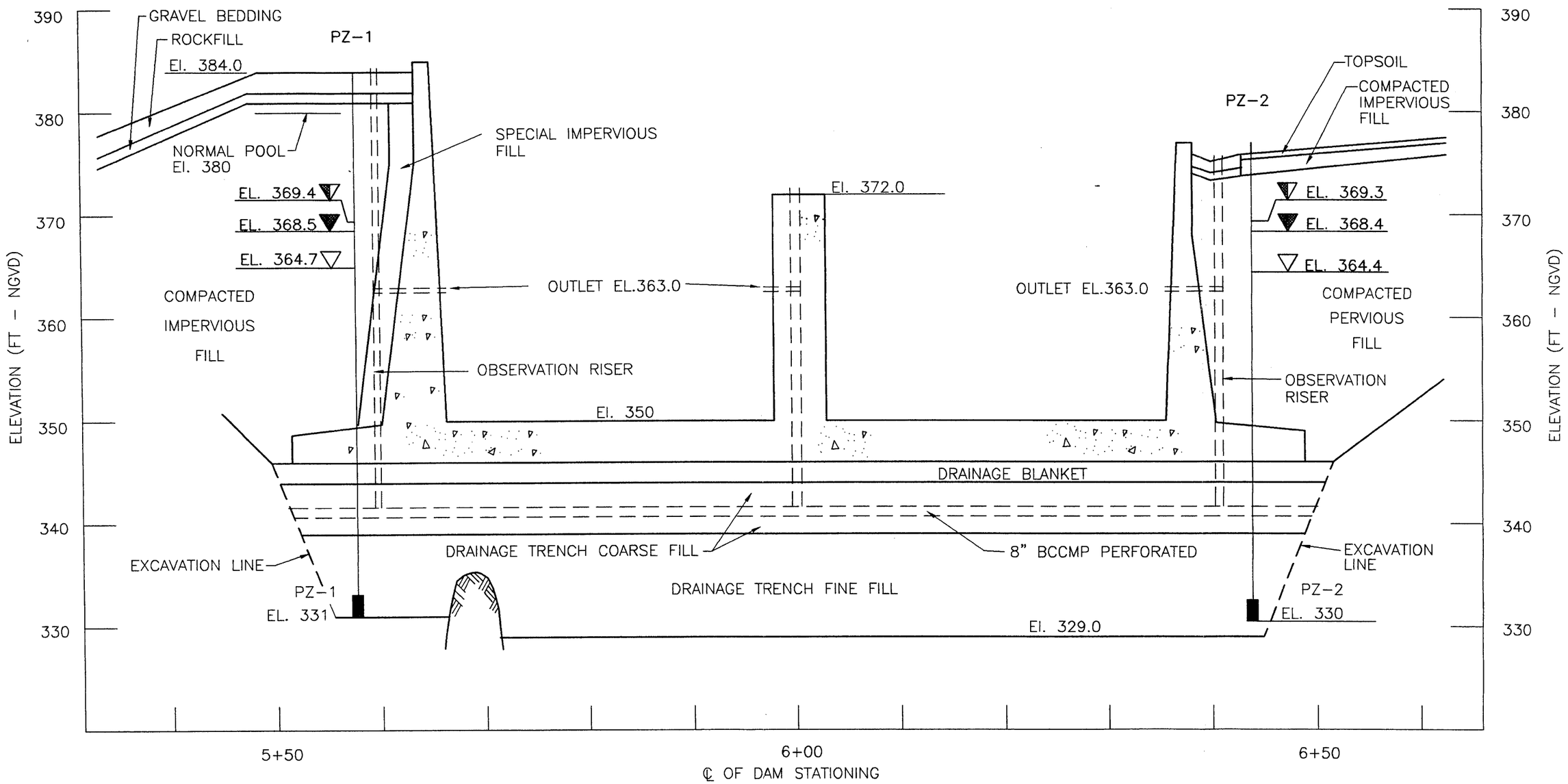
NOTES:

1. SEE PLATE 6 FOR COMPLETE LOG DETAILS.
2. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. PIEZOMETER CONSTRUCTION DETAILS SHOWN FOR PZ-9 TYPICAL FOR ALL PIEZOMETERS.

0 20 40
SCALE, FEET

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	EAST OUTLET CHANNEL WALL
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 17

97487-08 11/20/97 DJM



LEGEND:

- ▽ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUND WATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUND WATER ELEVATION (DATA FROM 1992–1997)

SECTION D–D THROUGH STILLING BASIN (LOOKING UPSTREAM)

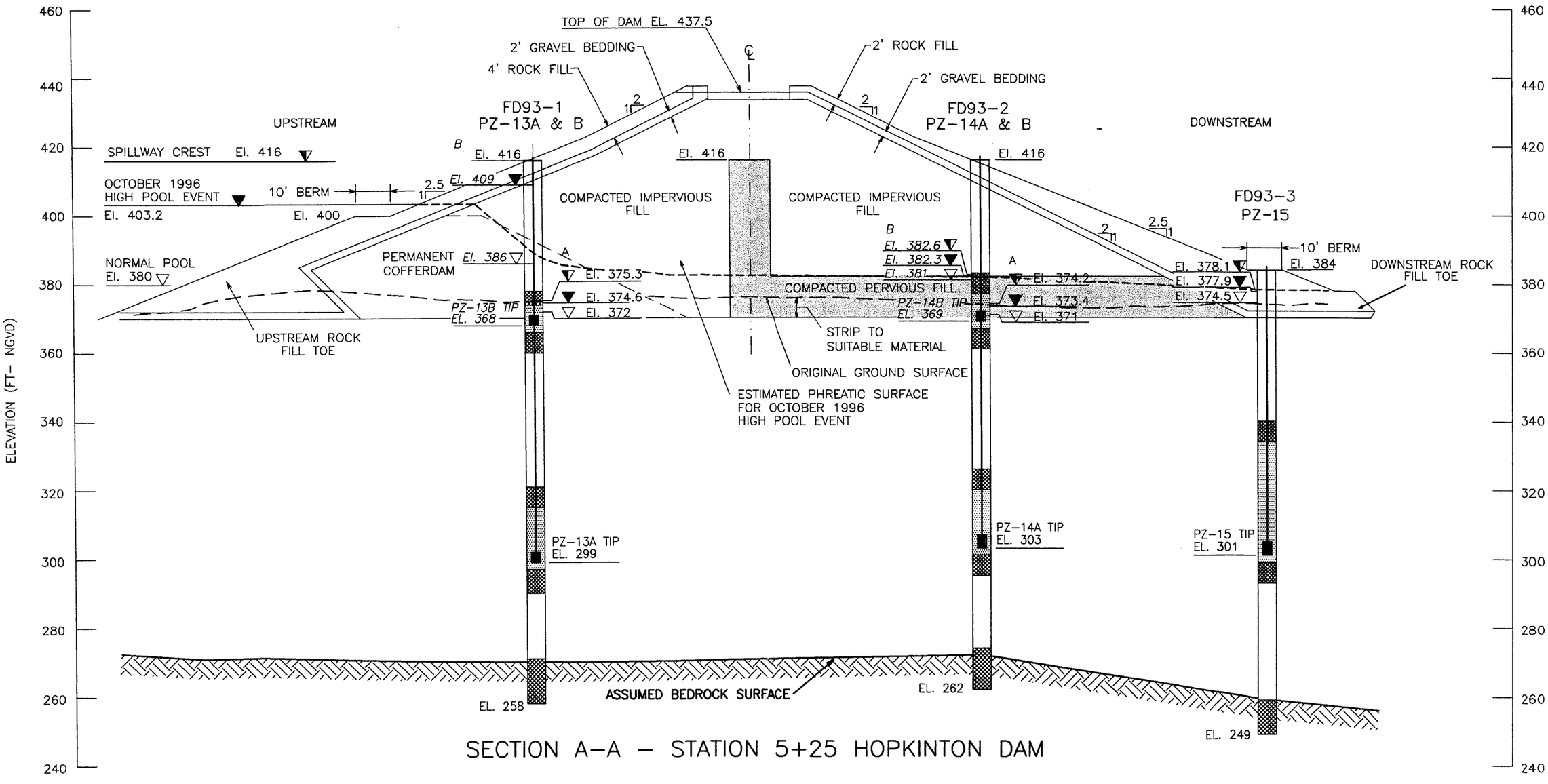
0 10 20
SCALE, FEET

NOTES:

1. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STILLING BASIN CROSS SECTION
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 18

97487-09 10/27/97 DJM



SECTION A–A – STATION 5+25 HOPKINTON DAM

LEGEND:

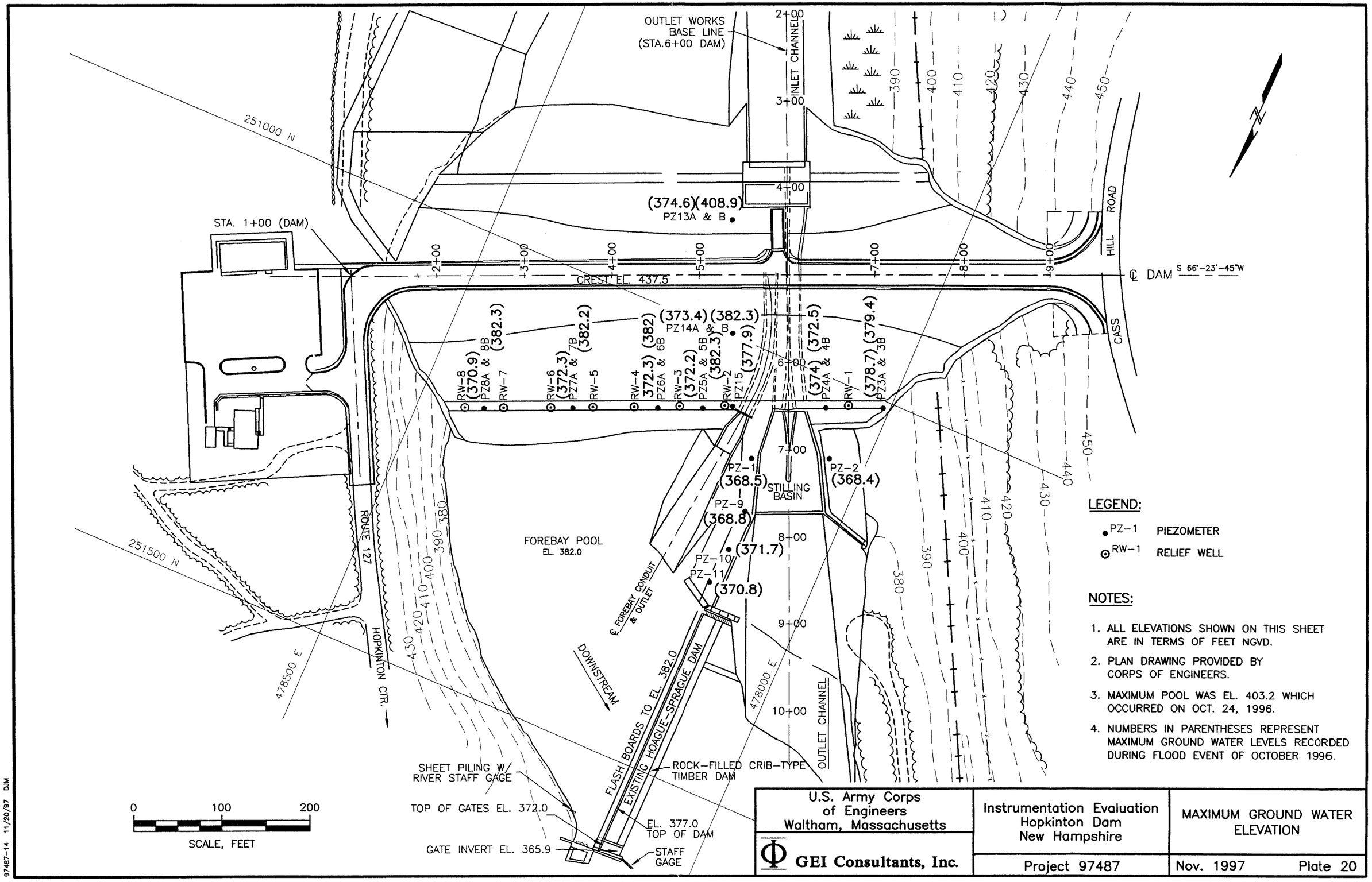
- ▼ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUND WATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUND WATER ELEVATION (DATA FROM 1994–1997)
- ---- ESTIMATED PHREATIC SURFACE, OCTOBER 1996 HIGH POOL EVENT

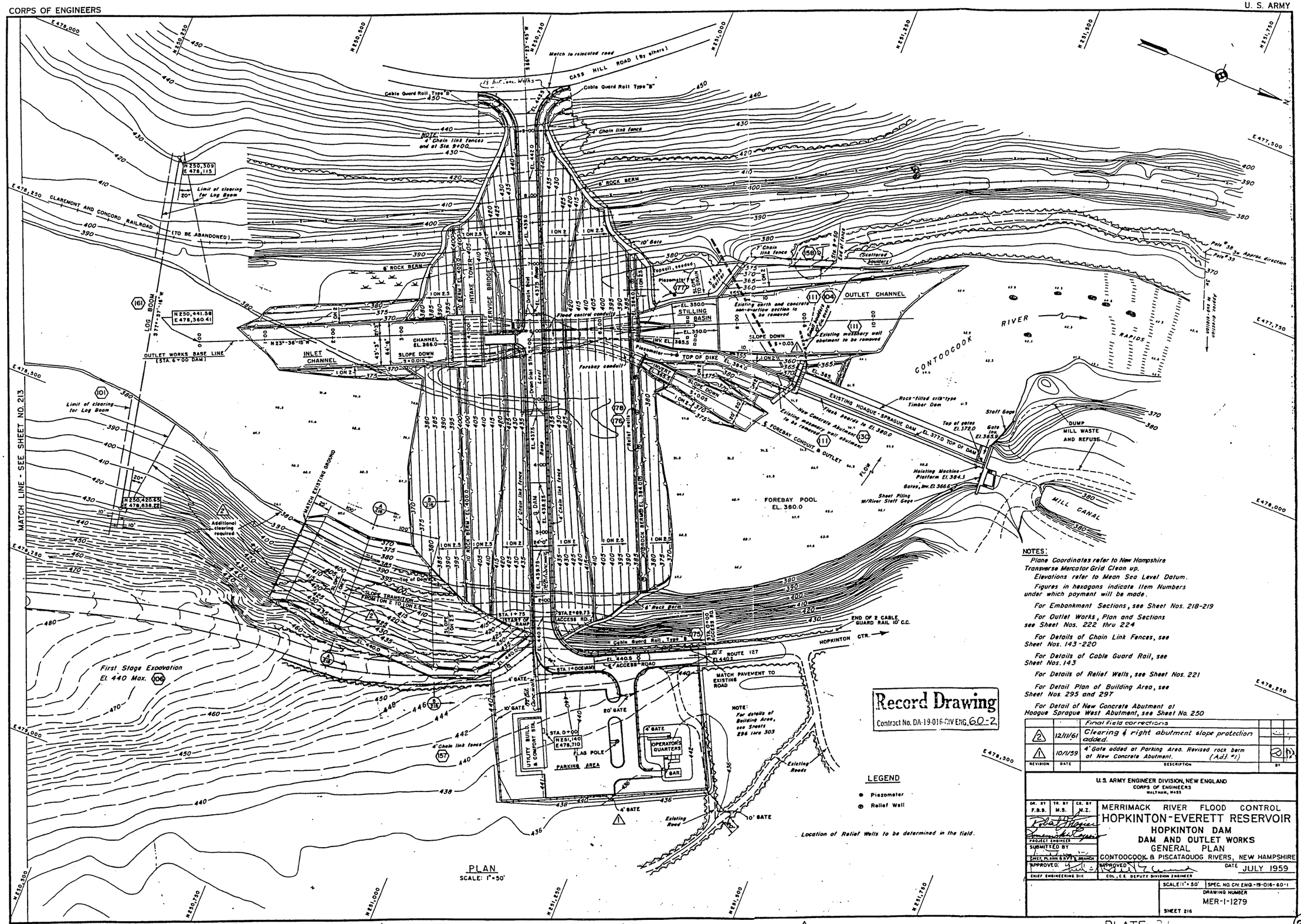
NOTES:

1. ALL ELEVATIONS ARE IN FEET NGVD.
2. SEE PLATES 9 – 11 FOR COMPLETE LOG DETAILS.
3. SECTION BASED ON DRAWING PROVIDED BY CORPS OF ENGINEERS.
4. NO PROJECTION OF PIEZOMETRIC ELEVATION WAS MADE FOR PZ–13B DUE TO SCATTER OF DATA

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STATION 5+25 WITH PIEZOMETRIC PORE WATER LEVELS
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 19

97487-10 11/20/97 DJM


OUTLET WORKS BASE LINE (STA.6+00 DAM)
INLET CHANNEL
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
251000 N
251500 N
478500 E
478000 E
STA. 1+00 (DAM)
(374.6)(408.9)
PZ13A & B
CREST EL. 437.5
℄ DAM S 66°-23'-45"W
HILL ROAD
CASS
(373.4)(382.3)
PZ14A & B
(382.3)
RW-8 (370.9) PZ8A & 8B
RW-7
RW-6 (372.3) PZ7A & 7B
RW-5 (382.2)
RW-4 372.3) (382)
PZ6A & 6B
RW-3 (372.2)
PZ5A & 5B
RW-2 (382.3)
PZ15 (377.9)
(374) (372.5)
PZ4A & 4B
RW-1 (378.7) (379.4)
PZ3A & 3B
PZ-1 (368.5)
PZ-2 (368.4)
STILLING BASIN
PZ-9 (368.8)
PZ-10 (371.7)
PZ-11 (370.8)
FOREBAY POOL EL. 382.0
ROUTE 127
HOPKINTON CTR.
℄ FOREBAY CONDUIT & OUTLET
DOWNSTREAM
FLASH BOARDS TO EL. 382.0
EXISTING HOAGUE-SPRAGUE DAM
OUTLET CHANNEL
ROCK-FILLED CRIB-TYPE TIMBER DAM
SHEET PILING W/ RIVER STAFF GAGE
TOP OF GATES EL. 372.0
GATE INVERT EL. 365.9
EL. 377.0 TOP OF DAM
STAFF GAGE
0 100 200
SCALE, FEET
LEGEND:
PZ-1 PIEZOMETER
RW-1 RELIEF WELL
NOTES:
1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. MAXIMUM POOL WAS EL. 403.2 WHICH OCCURRED ON OCT. 24, 1996.
4. NUMBERS IN PARENTHESES REPRESENT MAXIMUM GROUND WATER LEVELS RECORDED DURING FLOOD EVENT OF OCTOBER 1996.
U.S. Army Corps of Engineers Waltham, Massachusetts
GEI Consultants, Inc.
Instrumentation Evaluation Hopkinton Dam New Hampshire
Project 97487
MAXIMUM GROUND WATER ELEVATION
Nov. 1997
Plate 20
97487-14 11/20/97 DJM



NOTES:

Plane Coordinates refer to New Hampshire Transverse Mercator Grid Clean up.

Elevations refer to Mean Sea Level Datum.

Figures in hexagons indicate Item Numbers under which payment will be made.

For Embankment Sections, see Sheet Nos. 218-219

For Outlet Works, Plan and Sections see Sheet Nos. 222 thru 224

For Details of Chain Link Fences, see Sheet Nos. 143-220

For Details of Cable Guard Rail, see Sheet Nos. 143

For Details of Relief Wells, see Sheet Nos. 221

For Detail Plan of Building Area, see Sheet Nos. 295 and 297

For Detail of New Concrete Abutment at Hoague Sprague West Abutment, see Sheet No. 250

REVISION	DATE	DESCRIPTION	BY
		Final field corrections	
2	12/11/61	Clearing & right abutment slope protection added.	
1	10/1/59	4' Gate added at Parking Area. Revised rock berm at New Concrete Abutment. (Adj. #1)	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY F.B.S. TR. BY M.S. CK. BY N.Z.

PROJECT ENGINEER

SUBMITTED BY

CHIEF, PLANN & RPTS BRANCH

APPROVED:

CHIEF ENGINEERING DIV.

APPROVED

COL., C.E. DEPUTY DIVISION ENGINEER

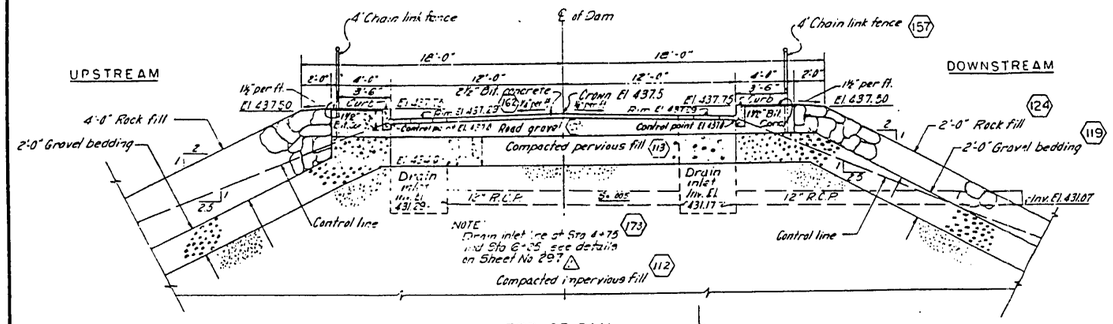
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
DAM AND OUTLET WORKS
GENERAL PLAN
CONTOOCOOK & PISCATAQUOG RIVERS, NEW HAMPSHIRE

DATE JULY 1959

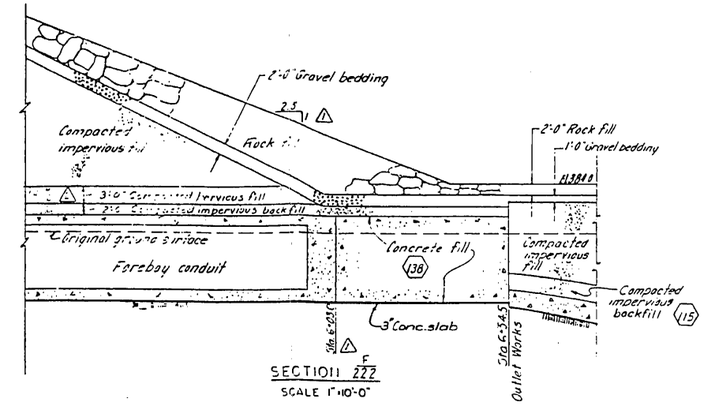
SCALE: 1" = 50' | SPEC. NO. CIV ENG-19-016-60-1

DRAWING NUMBER MER-1-1279

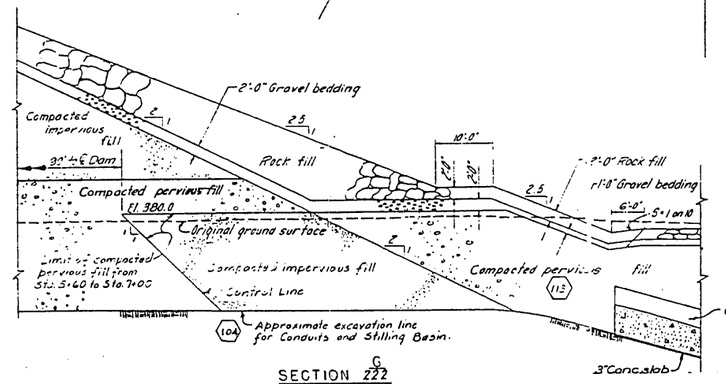
SHEET 216



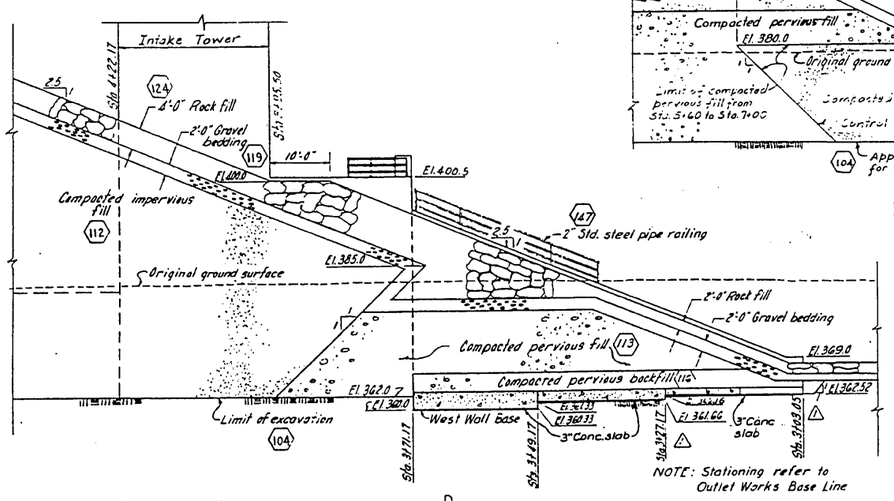
TOP OF DAM
TYPICAL SECTION
Sta. 4+75 to Sta. 6+25
SCALE: 1" = 4'-0"



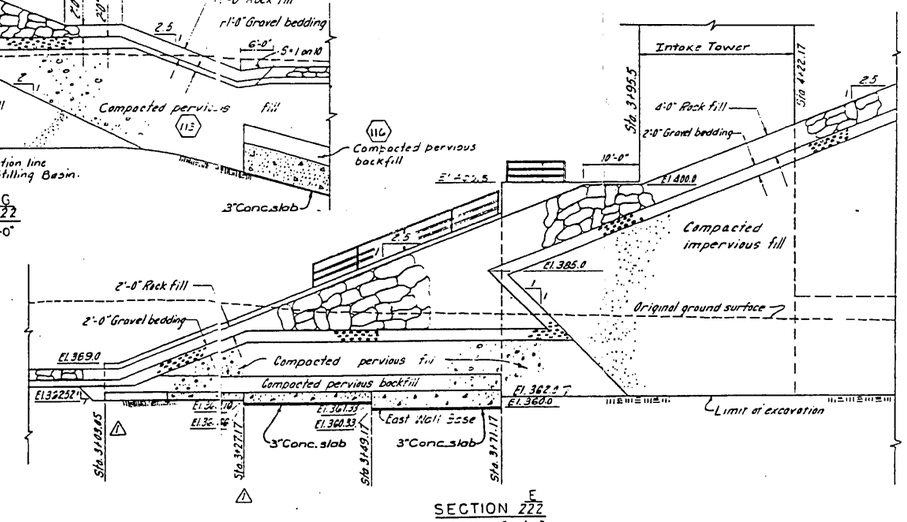
SECTION F 222
SCALE 1" = 10'-0"



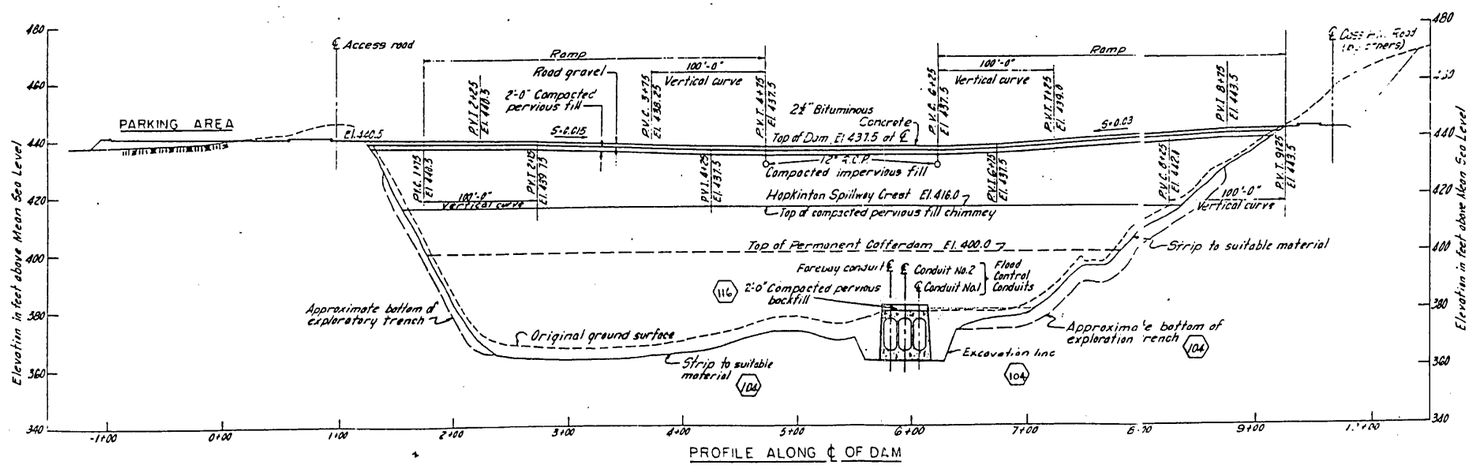
SECTION G 222
SCALE: 1" = 10'-0"



SECTION D 222
SCALE: 1" = 10'-0"



SECTION E 222
SCALE: 1" = 10'-0"



PROFILE ALONG ℄ OF DAM
SCALE HOR. 1" = 50'
VERT. 1" = 20'

NOTES

Elevations refer to Mean Sea Level Datum
For General Notes applying to this sheet, see Sheet No. 222
Figures in hexagons indicate Item Number under which payment will be made.
For embankment sections, see Sheet Nos. 218 & 219

Record Drawing
Contract No. DA-19-016-CIV ENG 60-2

REVISION	DATE	DESCRIPTION	BY
		Final field corrections	
2	10.9.59	3'-0" Compacted pervious fill added (Add #2)	
1	10.1.59	Slope and stationing added, sheet No. revised (Add. #1)	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY F.L.S. | DR. BY J.A.M. | CK. BY F.L.S.

PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANS & REPORTS BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
EMBANKMENT PROFILE & SECTIONS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

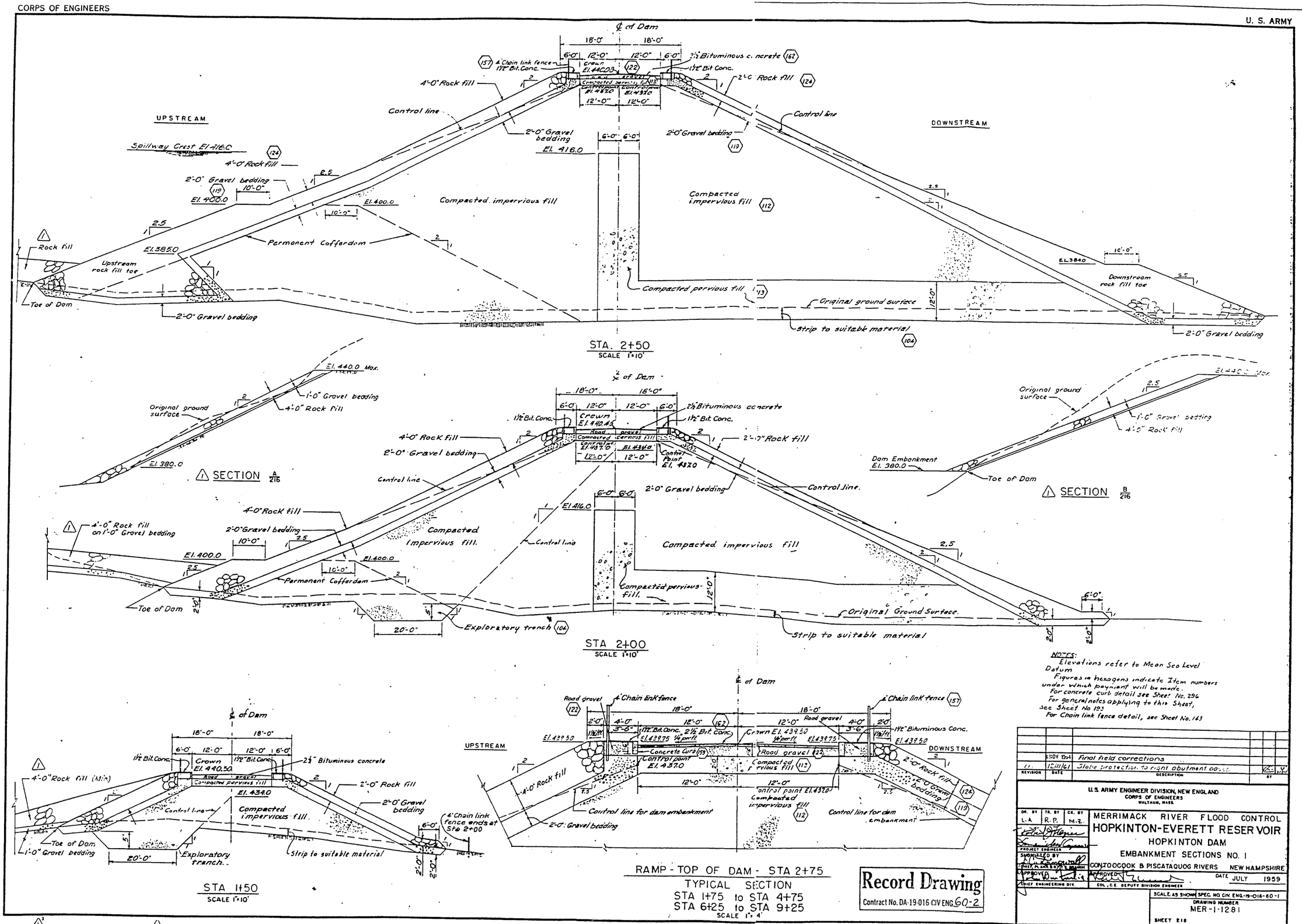
DATE JULY 1959

SCALE: AS SHOWN | SPEC. NO. CIV. ENG.-19-016-60-1

DRAWING NUMBER
MER-1-1280

SHEET 217

PLATE 22



NOTES:
Elevations refer to Mean Sea Level Datum
Figures in hexagons indicate Item numbers under which payment will be made.
For concrete curb detail see Sheet No. 296
For general notes applying to this Sheet, see Sheet No 193
For Chain link fence detail, see Sheet No. 143

REVISION	DATE	DESCRIPTION	BY
11	12/11/61	Final field corrections	
		Slope protection to right abutment ...	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY L.A. | TR. BY R.P. | CK. BY M.Z.

PROJECT ENGINEER

SUBMITTED BY

CHIEF, PLANN. & R.P. BRANCH

APPROVED

CHIEF ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
EMBANKMENT SECTIONS NO. 1
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

APPROVED

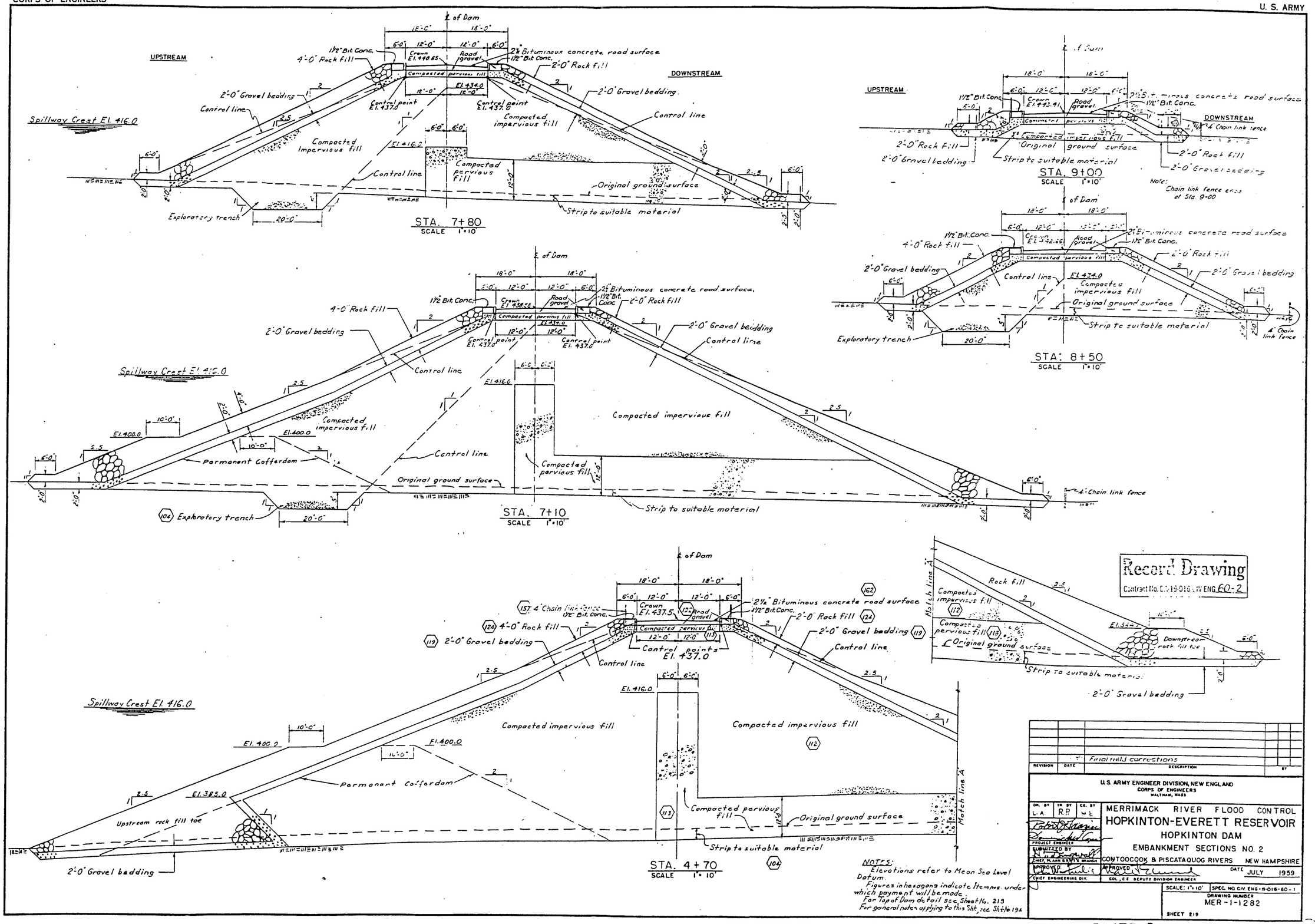
COL., C.E. DEPUTY DIVISION ENGINEER

DATE JULY 1959

SCALE AS SHOWN | SPEC. NO. CIV. ENG.-19-016-60-1

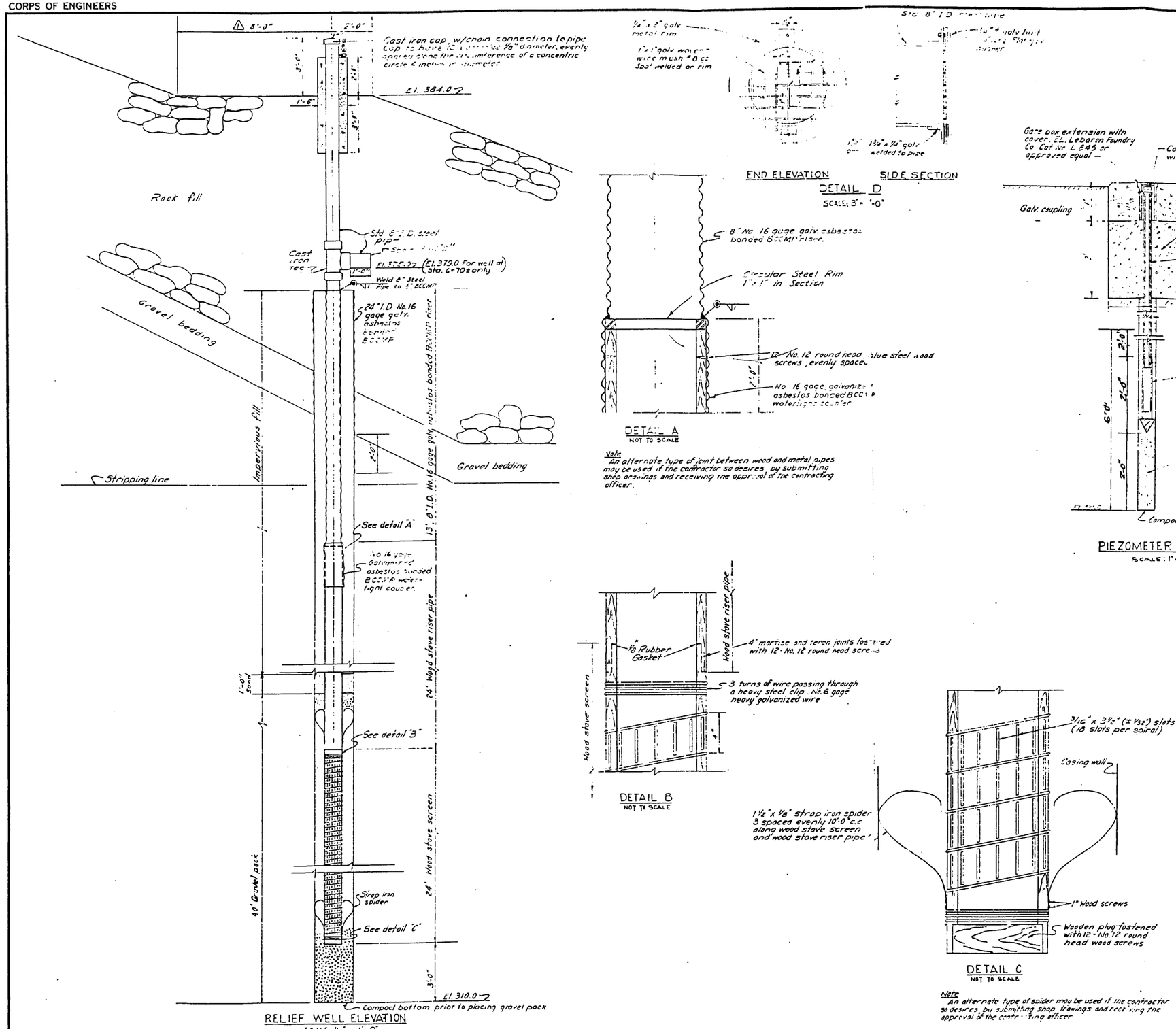
DRAWING NUMBER MER-1-1281

SHEET 218



NOTES:
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate Items under which payment will be made.
For Top of Dam detail see Sheet No. 213
For general notes applying to this Sht. see Sht. No. 192

PLATE 24



Record Drawing
Contract No. DA-19-016-CIV ENG. 60-2

NOTES

Elevations refer to Mean Sea Level Datum.
Description of Relief Wells and Piezometers, see Sheet Nos. 216 & 246.
Relief Wells will be paid for under Item Numbers 176 and 178.
Piezometers will be paid for under Item Number 177.

REVISION	DATE	DESCRIPTION	BY
		Final field corrections	
1	10/1/59	Dimension corrected from 10'-0" to 5'-0" on Relief Well (Add. #1)	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY A.H. | TR. BY C.B. | CK. BY A.H.

K. A. Linell
CHIEF, HED LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & RPTS. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
DETAILS OF RELIEF WELLS AND PIEZOMETERS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

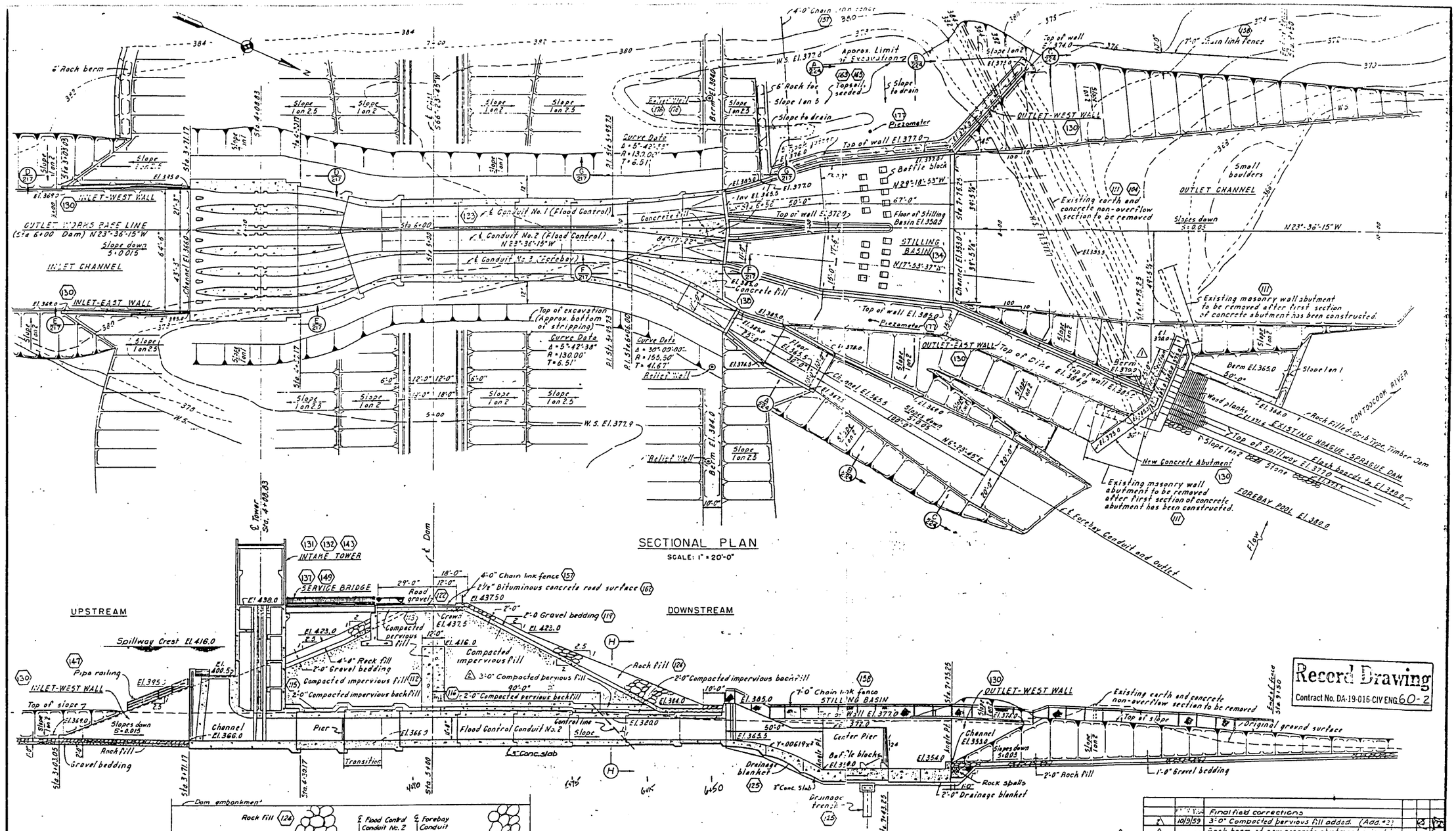
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

DATE JULY 1959

SCALE: AS SHOWN | SPEC. NO. CIV ENG.-19-016-60-1
DRAWING NUMBER MER-1-1284
SHEET 221

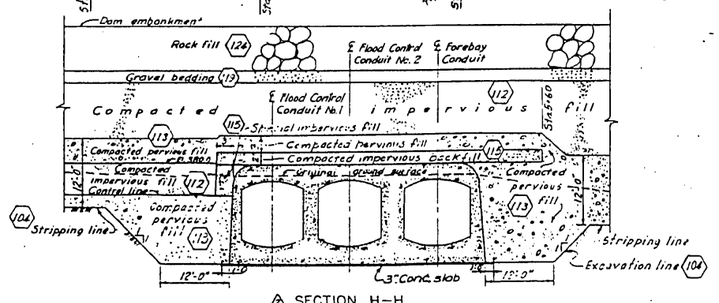
PLATE 25

221



SECTIONAL PLAN
SCALE: 1" = 20'-0"

SECTION ALONG ℄ CONDUIT NO. 2
SCALE: 1" = 20'-0"



SECTION H-H
SCALE: 1" = 10'-0"

NOTES:

Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item number under which payment will be made.
For outlet works sections, see Sheet Nos. 223 & 224.
For intake tower concrete details, see Sheet Nos. 226 thru 231.
For conduit concrete details, see Sheet Nos. 236 thru 243.
For forebay conduit outlet channel concrete details, see Sheet No. 247.
For inlet and outlet channel concrete walls details, see Sheet Nos. 225, 248, 249 & 250.
For embankment sections, see Sheet Nos. 217 thru 219.
For service bridge plan and details, see Sheet Nos. 292 thru 294.
For details of piezometers and relief wells, see sheet No. 221.
For stilling basin concrete details, see Sheet Nos. 244 thru 246.

Record Drawing
Contract No. DA-19-016-CIV ENG 60-2

REVISION	DATE	DESCRIPTION	BY
		Final field corrections	
2	10/9/59	3'-0" Compacted pervious fill added. (Add. #2)	
1	10/1/59	Rock berm at new concrete abutment raised to El. 370.0. Revision block added. (Add. #1)	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY F.L.S. | DR. BY R.J.C. | CK. BY M.Z.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
OUTLET WORKS
PLAN & SECTION
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

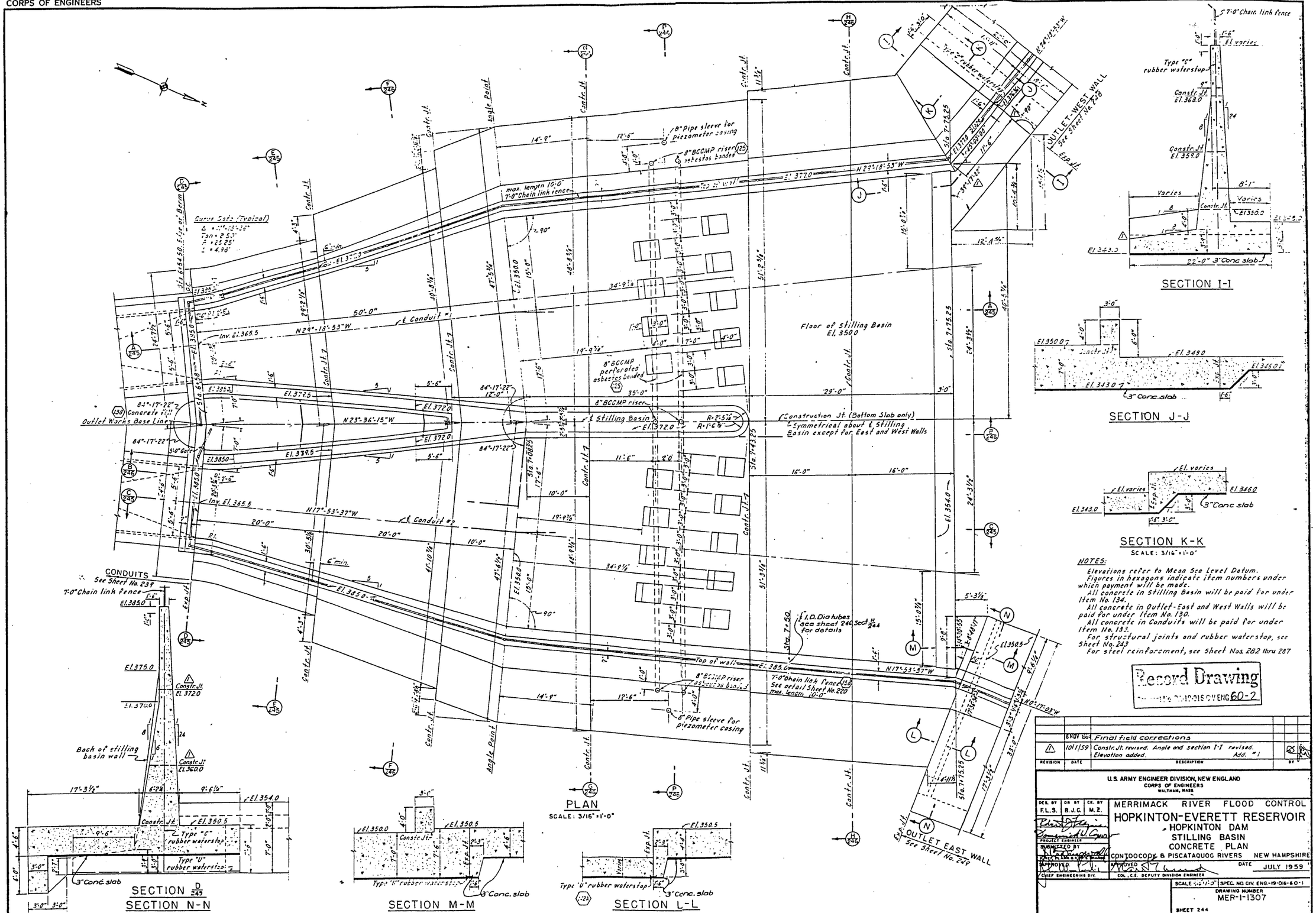
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANNING & REPORTS BRANCH
APPROVED: CHIEF ENGINEERING DIV.
APPROVED: COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959
SCALE AS SHOWN | SPEC. NO. CIV. ENG.-19-016-60-1
DRAWING NUMBER MER-1-1285
SHEET 222

PLATE 2

222

CORPS OF ENGINEERS

U. S. ARMY



NOTES:

Elevations refer to Mean Sea Level Datum.

Figures in hexagons indicate item numbers under which payment will be made.

All concrete in Stilling Basin will be paid for under Item No. 134.

All concrete in Outlet-East and West Walls will be paid for under Item No. 130.

All concrete in Conduits will be paid for under Item No. 133.

For structural joints and rubber waterstop, see Sheet No. 243

For steel reinforcement, see Sheet Nos. 282 thru 287

Record Drawing

Contract No. 20-10-016 CIV ENG 60-2

REVISION	DATE	DESCRIPTION	BY
	6 NOV 1959	Final field corrections	
1	10/1/59	Constr. Jt. revised. Angle and section I-I revised. Elevation added. Add. #1	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY F.L.S. | DR. BY R.J.C. | CK. BY M.Z.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
STILLING BASIN
CONCRETE PLAN
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

PROJECT ENGINEER

SUBMITTED BY

APPROVED

CHIEF ENGINEERING DIV.

APPROVED

COL., C.E. DEPUTY DIVISION ENGINEER

DATE JULY 1959

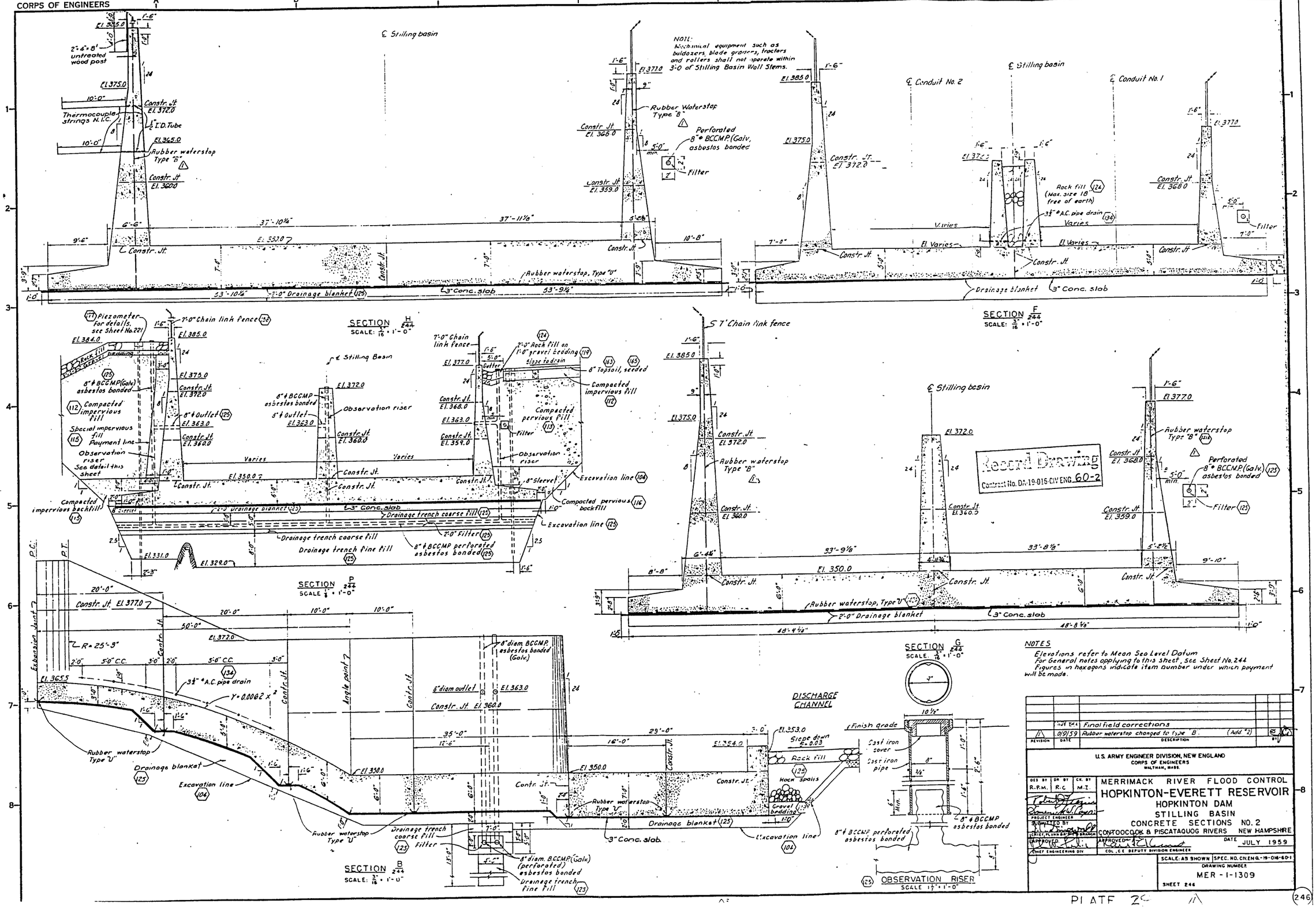
SCALE 3/16" = 1'-0" | SPEC. NO. CIV. ENG.-19-016-60-1

DRAWING NUMBER MER-1-1307

SHEET 244

PLATE 27

244


CORPS OF ENGINEERS
U. S. ARMY
SECTION H 244
SCALE: 3/16" = 1'-0"
SECTION F 244
SCALE: 3/16" = 1'-0"
SECTION P 244
SCALE: 1/8" = 1'-0"
SECTION G 244
SCALE: 3/16" = 1'-0"
SECTION B 244
SCALE: 3/16" = 1'-0"
OBSERVATION RISER
SCALE 1 1/2" = 1'-0"
DISCHARGE CHANNEL
Record Drawing
Contract No. DA-19-016-CIV ENG 60-2
NOTES
Elevations refer to Mean Sea Level Datum
For General notes applying to this sheet, see Sheet No. 244
Figures in hexagons indicate item number under which payment will be made.
Final field corrections
Rubber waterstop changed to type B. (Add #2)
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
STILLING BASIN
CONCRETE SECTIONS NO. 2
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959
SCALE: AS SHOWN
SPEC. NO. CIV.ENG.-19-016-60-1
DRAWING NUMBER
MER-1-1309
SHEET 246
PLATE 2
246

CORPS OF ENGINEERS, U. S. ARMY
NEW ENGLAND DIVISION
FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

Site HOPKINTON DAM EXPLORATION PROGRAM PROJECT NO. DACW33-93-D-0004

Page 1 of ___ Pages

Hole No. FD93-1 Diam. (Casing) 4"HW 5"PW

Boring Started OCTOBER 5, 1993

Co-ordinates: N 250877.22 E 478249.90

Boring Completed OCTOBER 19, 1993

Drilled by ROB PRICE, DARIUS WINTERS (ATL)

Report Submitted ___

Purpose of Exploration TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTION AS WELL AS INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Toe of Hole 416 NGVD ~~M.S.L.~~

Total Overburden Drilled 144.5 Feet

Elevation Top of Rock 271.5 NGVD ~~M.S.L.~~

Elevation Bottom of Hole 258 NGVD ~~M.S.L.~~

Total Rock Drilled 13.5 Feet

Total Depth of Hole 158 Feet

Core Recovered 65 %

Core Recovered 6 Ft.: 6 IN Diam. 2.1 In.

Soil Samples 2 1/2 In. Diam. 68 No.

Soil Samples ___ In. Diam. ___ No.

Casing Left in Place 0 Feet

PIEZOMETERS PROTECTED WITH 10 FEET 4" DIA STEEL CASING (2 FT. STICK UP)

Water Table Depth -46 Ft.

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	158	ROTARY-WASH

INDEX

Ground Water	Back of Page	
Boring Location Sketch	Back of Page	
Overburden Record	Page	
Rock Drilling	Page	
	Page	
	Page	
	Page	

Prepared by Tom Eldridge
Field Data Lab. Data

Submitted by ___

NED FORM DEC 63 121

REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

PLATE A.1

U. S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM Page 1 of 10 Pages

Boring No. FD93-1 Desig. FD93-B Diam. (Casing) 5" PW & 4" HW

Co-ordinates: N 250877.22 E 478249.90

Elevation Top of Boring 416 NGVD ~~MSL~~ Hammer Wt. 300 Boring Started 10/5/93

Total Overburden Drilled 144.5 Feet Hammer Drop 18" Boring Completed 10/19/93

Elevation Top of Rock 271.5 NGVD ~~MSL~~ Casing Left

Total Rock Drilled 13.5 Feet Subsurface Water Data Page

Elevation Bottom of Boring 258 NGVD ~~MSL~~ Obs. Well

Total Depth of Boring 158 Feet Drilled By ROB PRYCE, DARIUS WINTERS

Core Recovered 65 % No. Boxes 1 Mfg. Des. Drill CME-55

Core Recovered 6 Ft : 6" Diam. 2-1 In. Inspected By: MARK WILBUR T ELDRIDGE

Soil Samples 2 1/2 In. Diam. 68 No. Classification By: MARK WILBUR T ELDRIDGE

Soil Samples In. Diam. No. Classification By:

DEPTH		CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
							Rock Riprap
406	10			16.0 TO 17.0	15	10 FT 300 lb HAMMER 18" DROP NW ROD 2 1/2 ID SPLIT SPOON	Br. Silty, Clayey (30-40) SAND
	11	S-1			12		
					10		
					13		(SC/SM)
	12			17.0 TO 18.0	20	12'	Br. Sandy (30-40) SILT w/ tr. Gravel (0-5)
	13	S-2			29	SIMILIAR PROCEDURE ROLLER BIT & WASH TO 14'	
					24		
	14			14.0 TO 15.0	26		
					11		
	15	S-3			34	300 lb HAMMER, 18" DROP NW ROD 2 1/2" ID. SPLIT SPOON, SPUN/WASH PW CASING TO 15'	
					22		
	16			16.0 TO 17.0	28		
					34		
	17	S-4			35		(ML)
					41	SIMILIAR PROCEDURE	
398	18				46		

GENERAL REMARKS: 10' OVERBURDEN, NO SAMPLING REQUIRED. REMOVED 2' OF RIP-RAP BY HAND SPUN PW (5") CASING TO -10' DEPTH. ROLLER BIT & WASH TO -10' DEPTH

ED 1 MAR 58 (Test)

Boring No. FD93-1

PLATE A.2

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE REC'VT	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
398 18				10		Br. Sandy (30-40) SILT with Gravel (0-5)
				21		
19	S-5			100/3"	REFUSAL @ 19.3' (POSSIBLE COBBLE) INSTALL ROLLER BIT SPIN CASING TO 20'	
20			20.0	23	20'	(ML)
			TO	27		
21	S-6		22.0	37	300 lb HAMMER, 18" DROP NW ROD, 2½" I.D. SPLIT SPOON	
				38		
22			22.0	37		
				23	SIMILIAR PROCEDURE	COBBLES & BOULDERS
23	S-7		TO	64	ROLLER BIT & WASH 20-24'	
			24.0	57		
24			24.0	19		Br. Sandy (30-40) SILT
				24	300 lb HAMMER, 18" DROP NW ROD, 2½" I.D. SPLIT SPOON (END OF WORK DAY 7:00 PM)	
25	S-8		TO	30		
			26.0	43	SPUN/WASH PW CASING TO 25	
26			26.0	47		
			TO	49		
27	S-9			36	300 lb HAMMER, 18" DROP NW ROD, 2½" I.D. SPLIT SPOON	
			28.0	31		
28			28.0	35		
			TO	37		
29	S-10			45	SIMILIAR PROCEDURE	
			30.0	33	SPUN/WASH PW CASING TO 30', 3RD GEAR, RELATIVELY EASY DRILLING, INSTALL ROLLER BIT & WASH 26 TO 30'	
30			30.0	23		(ML)
			TO	27		
31	S-11		32.0	12	300 lb HAMMER, 18" DROP NW ROD, 2½" I.D. SPLIT SPOON	
				14		
32			32.0	23		
				16		
33	S-12		TO	24	SIMILIAR PROCEDURE	
			34.0	20	SPUN/WASH PW CASING 30 TO 34', 3RD GEAR RELATIVELY EASY DRILLING, INSTALL ROLLER BIT & WASH TO 35'	
382 34				32		
				32		

N 58A(Test)

Boring No. FD93-1

PLATE A.3

	DEPTH (Ft.)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
382	34			34.0 TO 36.0	33 26	300 lb Hammer, 18" Drop NW Rod 2½" split spoon sampler	Br. Sandy (30-40) SILT (ML)
	35	S-13					
	36			36.0 TO 38.0	46 65 47 52	36' Similiar procedure	Br. Sandy (35-45) SILT with little Gravel (0-10) (ML)
	37	S-14					
	38			38.0 TO 40.0	42 28 39 45		Lt. Br. SILT with little Sand (0-10) (ML)
	39	S-15					
	40			40.0 TO 40.9	100 100/5"	300 lb Hammer, 18" Drop NX Rod 2½", split spoon sampler. Refusal @ 40.9' Install roller bit and advance through 5" cobble	Dk. Br. Sandy (25-35) SILT with Gravel (ML)
	41	S-16					(NS)
	42			42.0 TO 44.0	29 37 63 59	Similiar procedure	Dk. Br. Sandy (25-35) SILT with Gravel (ML)
	43	S-17					
	44			44.0 TO 46.0	35 35 37 48		Br. Silty (30-40) SAND with Gravel (SM)
	45	S-18					
	46			46.0 TO 48.0	21 23 51 34	300# Hammer, 18" Drop NX Rod, 2½" ID split spoon sampler	Dk. Br. Sandy (25-35) SILT with Gravel, slightly plastic (ML)
	47	S-19					
	48			48.0 TO 50.0	35 22 44 49	48' Similiar procedure spun/wash PW (5") casing to 45', install roller bit and advance to 50' 3rd gear, relatively easy Drilling	
	49	S-20					
366	50						

EL :58A(Test)

Boring No. FD93-1

PLATE A.4

DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH (ft)	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
366 50				22	300 lb HAMMER, 18" DROP	Dk. Gr. Sandy (25-35) SILT w/tr. Gravel, Slightly plastic
			50.0	22	NX ROD, 2½ I.D. SPLIT SPOON	
51	S-21		TO	13	SAMPLER	
			52.0	24		
52				26		
			52.0	39	SIMILIAR PROCEDURE	
			TO			
53	S-22			87	SPIN/WASH PW (5") CASING	
			54.0	76	TO 50' (STOPPAGE OF WORK DAY)	
					ROLLER BIT & WASH TO -54'	
54						
	S-23		54.0	29	300 lb. HAMMER 18 IN. DROP	
			TO	92	NX ROD 2½" I.D. SPLIT SPOON	
55						
			56.0	65	3⅞" ROLLER BIT & WASH TO	
				164	-56 FT.	
56						
	S-24		56.0	33	300 lb. HAMMER 18 IN DROP	(ML)
			TO	250	NX ROD 2½" I.D. SPLIT SPOON	
57			58.0	120	SPIN & WASH 5" PW CASING 5 FT.	
					TO -55 FT.	
				177	ROLLER BIT & WASH TO -58 FT.	
58						
	S-25		58.0	60	300 lb. HAMMER 18 IN DROP	
			TO	60	NX ROD 2½" I.D. SPLIT SPOON	
59			60.0	110	ROLLER BIT & WASH TO -60 FT.	
				148		
60			60.0	95	300 lb HAMMER 18 IN DROP	Dk. Gr. Sandy (25-35) SILT w/tr. Gravel & Rock Frags (10-20) (ML)
	S-26		TO	150/3	NW ROD 2½" I.D. SPLIT SPOON	
			60.8			
61					ROLLER BIT & WASH TO -62 FT.	
					WASH WITH DRILLING MUD TO CLEAR CAVINGS & WASH	(NS)
62						
	S-27		62.0	73	ADVANCE 5" PW CASING TO	Dk. Gr. Sandy (25-35) SILT w/tr. Gravel & Rock Frags. (10-20) (ML)
			TO	71	-62 FT. / ROLLER BIT & WASH	
63					300 lb HAMMER 18 IN. DROP	
			64.0	73	NW ROD 2½" I.D. SPLIT SPOON	
				78		
64						
	S-28		64.0	46	300 lb HAMMER 18 IN. DROP	Dk. Gr. Sandy (15-25) CLAY w/tr. Gravel (CL)
			TO	46	NW ROD 2½" I.D. SPLIT SPOON	
65				70		
			65.8	120/4	SPIN & WASH 5" PW CASING	
					TO -65 FT.	
350 66						(NS)

No. 58A (Test)

Boring No. PD93-1

PLATE A.5

	DEPTH (Ft.)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
350' EL.	66						
		S-29		66.0 To 68.0	20 26 42 53	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk Gr. Sandy (25-35) CLAY
	67						
	68	S-30		68.0 To 69.8	88 70 137 160/3	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON; SPIN & WASH 5" PW CASING TO -70 FT.	CL
	69						
	70	S-31A		70.0 To 72.0	19 25 39 43	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	
	71						
		S-31B					
	72	S-32		72.0 To 74.0	34 33 57 52	300 lb. HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON; ADVANCE 5" PW CASING TO -75 FT.	Gr. m-f Clayey (25-35) SAND (SC)
	73						Gr. m-f SAND w/tr. silt & tr. Gravel (SP)
	74						74'
		S-33		74.0 To 76.0	26 37 52 50	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT/WASH TO -76 FT.	Gr. mostly f. silty (20-30) SAND w/ tr. gravel, slightly plastic
	75						
	76	S-34		76.0 To 78.0	47 75 100 150	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -78 FT	(SM)
	77						
	78	S-35		78.0 To 79.2	44 57 100/2 BOULDER REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; INSERT 4" HW CASING IN TO BORE HOLE AND SPIN/WASH TO -79.5 FT. ROLLER BIT W	
336.8	79						
CT 11 336' EL.	80	S-36		80.0 To 81.3	73 65 160/4	3 7/8" BIT TO -80 FT. 3 RPGEAR 3/4 THROTTLE 300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT/WASH TO -82 FT.	Gr. m-f silty (15-25) SAND (SM)
	81						
	82						(NS)

NED FORM 58A (Test)

Boring No. FD93-1

PLATE A.6

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
334'	82	S-37		82.0 to 84.0	46 60 66 72	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; SPIN/WASH HW CASING TO -84 FT. 3RD GEAR moderately DIFFICULT 3/4 throttle DRILLING	Gr. m-f Silty (15-25) SAND
	83						
	84	S-38		84.0 To 86.0	56 85 133 138	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; ROLLER BIT TO -86 FT. AND WASH	(SM)
	85						
	86	S-39		86.0 To 88.0	58 82 95 95	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; SPIN/WASH HW CASING TO -88 FT.	
	87						
CT 12	88	S-40		88.0 To 90.0	31 35 40 38	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; SPIN/WASH CASING TO 90 FT.	Gr. Sandy (15-25) CLAY w/silt lamin. & little gravel (5-15) (CL)
	89						
	90	S-41		90.0 To 92.0	18 26 33 132	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; ROLLER BIT/WASH TO 92 FT	Gr. fat CLAY (CH)
	91						
	92	S-42			60/0	300 lb HAMMER 18 IN DROP NW ROD; ROLLER BIT THROUGH 9" BOULDER	Possible Cobbles & Boulders (NR)
	93						
	94	S-43		94.0 To 95.1	25 50 100/1	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; SPIN, WASH CASING TO -95'; ROLLER BIT & WASH TO -96'	Gr. fat CLAY (CH)
	95						(NS)
	96			96.0 To 97.4	33 68 200/5	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON; ROLLER BIT TO -98 FT.	Gr. SILT w/f. Sand (20-30) (ML)
	97						(NS)
318'	98						

ED Form 58A (Test)

Boring No. FO 93-1

PLATE A.7

ELEV	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
318	10	S-45		98.0 TO 99.0	76 / 164	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Gr. Silty (20-30) SAND w/little Gravel (5-15) (SM) (NS)
	99				60/0	~~ADVANCE CASING TO -100 FT.~~	
316	100	S-46		100 TO 100.2	100/2 Bouldering REF	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT & WASH TO -102'	Granite Rock Frags (NS)
	101						
	102	S-47		102.0 TO 102.2	171 / 150/2	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT & WASH BOREHOLE TO -104 FT.	Gr. Silty (20-30) SAND w/little Gravel (5-15) (SM) (NS)
	103						
	104	S-48		104.0 TO 104.4	200/5	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT / WASH BORING TO -104 FT.	Br. Silty, Clayey (21) SAND w/little Gravel (10) (SC/SM) (NS)
	105						
	106	S-49		106.0 TO 106.7	151 / 100/2	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT / WASH BORING TO -108 FT.	Br. Well-graded SAND w/Gravel (10-20) (SW) (NS)
	107						
	108	S-50		108.0 TO 108.8	70 / 100/3	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON SPIN / WASH 4" HW CASING TO -110 FT ROLLER BIT WASH CASING TO -110 FT.	Br. Silty (15-25) SAND w/Gravel (15-25) (SM) (NS)
	109						
OCT 13	110	S-51		110.0 TO 110.2	200/2	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT & WASH BOREHOLE TO -112' 3RD GEAR 1/2 3/4 throttle RELATIVELY DIFFICULT DRILLING	Br. SAND w/Silt (5-15) (SP-SM) (NS)
	111						
	112	S-52		112.0 TO ~~113.1~~ 112.6	145 / 60/1	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON ROLLER BIT & WASH TO -114 FT.	Br. Sandy (30-40) CLAY w/little Gravel (0-10) (CL) (NS)
	113						
302	114						

NED Form 58A (Test)

Boring No. FD 93-1

PLATE A.8

DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
302 114	S-53		114.0 TO 114.3	120/3 Bounced REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ADVANCE 4" CASING, SPIN/WASH TO -115 FT. ROLLER BIT TO -116 FT.	Br. Sandy (30-40) CLAY with little Gravel (0-10) (CL) (NS)
115						
116	S-54		116.0 TO 116.4	150/5	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT, WASH BOREHOLE TO -118 FT. DIFFICULT DRILLING & BOUNCING OF RIG CONTINUE ROLLER BIT & WASH through Cobble & GRAVEL TO -120 FT. SPIN & WASH HW CASING TO -120 FT. DIFFICULT - 4TH GEAR 3/4 THROTTLE	Br. SAND W/Silt (B) (SP-SM) (NS)
117						
118						
119						
120	S-55		120.0 TO 120.9	125 125/3	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON ROLLER BIT TO -122 FT., 2ND GEAR 121 ½-¾ throttle	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM) (NS)
121						
122	S-56		122.0 TO 123.0	101 246	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT BOREHOLE & WASH TO -124 FT.	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM) (NS)
123						
124	S-57		124.0 TO 124.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -126 FT. SHAKING/ROCKING	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM) (NS)
125						
126	S-58		126.0 TO 126.5	170 REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH BOREHOLE RELATIVELY DIFFICULT TO -128 FT.	Br. Silty (10-20) well-graded SAND w/Gravel (10-20) (SM) (NS)
127						
128	S-59		128.0 TO 128.4	150/5	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON SPUN/WASHED HW CASING TO 130 FT. ROLLER BIT TO SAME	Br. Well-graded SAND w/Silt (5-15) (SW-SM) (NS)
129						
286 130						

ED Form 58A (Test)

Boring No. FD 93-1

PLATE A.9

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
286 — 130	S-60		130.0 TO 130.8	110 110/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -132'	Dk. Gr. Silty (30-40) SAND (SM) (NS)
131						
132	S-61		132.0 TO 132.4	157/6	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH BOREHOLE TO -134' 2ND GEAR ¾ throttle MODERATE DRILLING	Dk. Gr. Silty (30-40) SAND (SM) (NS)
133						
134	S-62		134.0 TO 134.8	102 150/3	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH BOREHOLE TO -136' 135.5'	Dk. Gr. Silty (30-40) SAND (SM) (NS)
135						
136	S-63		136.0 TO 137.6	34 59 112 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -138'	Br. Sandy (25-35) CLAY (CL) (NS)
137						
138	S-64		138.0 TO 139.6	54 60 130 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -140 FT.	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL) (NS)
139						
140	S-65		140.0 TO 140.8	64 150/3	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -142.0'	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL) (NS)
141						
142	S-66	142.0	142.0 TO 143.2	76 97 150/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -146 FT. ↓ -144.5' through COBBLES?	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL) (NS)
143						
144						
145						
270 — 146						

NED Form 58A (Test)

Boring No. FD93-1

PLATE A.10

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RUN	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
270	146	S-67		146.0 P 146.1	90/1	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON	Rock and/or Cobble Fragments
	147					ADVANCE NW CASING (HOLE NOT STAYING OPEN ? ROLLER BIT BINDING UP) TO -144.5' DEPTH	(NS)
	148					INCREASE THROTTLE SPEED @ -143.5' DEPTH	
	149				42" REC 70%	CORE ROCK WITH NX SIZE CORE BARREL DIAMOND BIT 1st 5 FT RUN DRILL TIME: 11 min 30 sec	
	150				R-1 RQD <10%	CORE ROCK BETWEEN -148 FT TO -153'	
	151						
	152						
263	153						Weathered Bedrock
	154				R-2 36" REC 60%	2nd 5 FT. RUN NX SIZE CORE BARREL @ DIAMOND BIT DRILL TIME: 10 min 30 sec. CORED ROCK BETWEEN -153 FT. TO -158 FT.	
	155						
	156				RQD 0		
	157						
258	158					TERMINATE BORING @ -158.0 FT.	

VED 58A(Test)

Boring No. F093-1

PLATE A.11

PLATE A.12

FIELD LOG OF TEST BORING IN ROCK

SITE HOPKINTON DAM HOLE NO. FD 93-1 PAGE 1

	DATE	DEPTH FT. FROM	DEPTH FT. TO	RUN FT.	RUN REC'V'Y FT.	REC'V'Y %	DRILLING BEHAVIOR: FEED	DRILLING BEHAVIOR: WATER	DRILLING BEHAVIOR: REASON FOR PULL	ACTUAL DRILLING TIME	BIT NO. SIZE AND TYPE	ADDITIONAL REMARKS
R-1	OCT 14	148.0	153.0	5 Ft	3.5 Ft.	70		NO WATER LOSS		11 min 30 SEC.	NX CORE DIAMOND	RQD = 10 WEATHERED GRANITE
R-2	OCT 15	153.0	158.0	5 Ft.	3 Ft.	60				10 min 30 SEC.	NX CORE DIAMOND	RQD = 0 WEATHERED GRANITE

TOTAL BED ROCK DRILLED 10 FEET

TOTAL BED ROCK RECOVERED 6.5 FEET

BED ROCK RECOVERY 65 PERCENT

DRILLER ROB PRICE

INSPECTOR TOM ELDRIDGE

NED FORM DEC 81 130

Site: HOPKINTON DAM

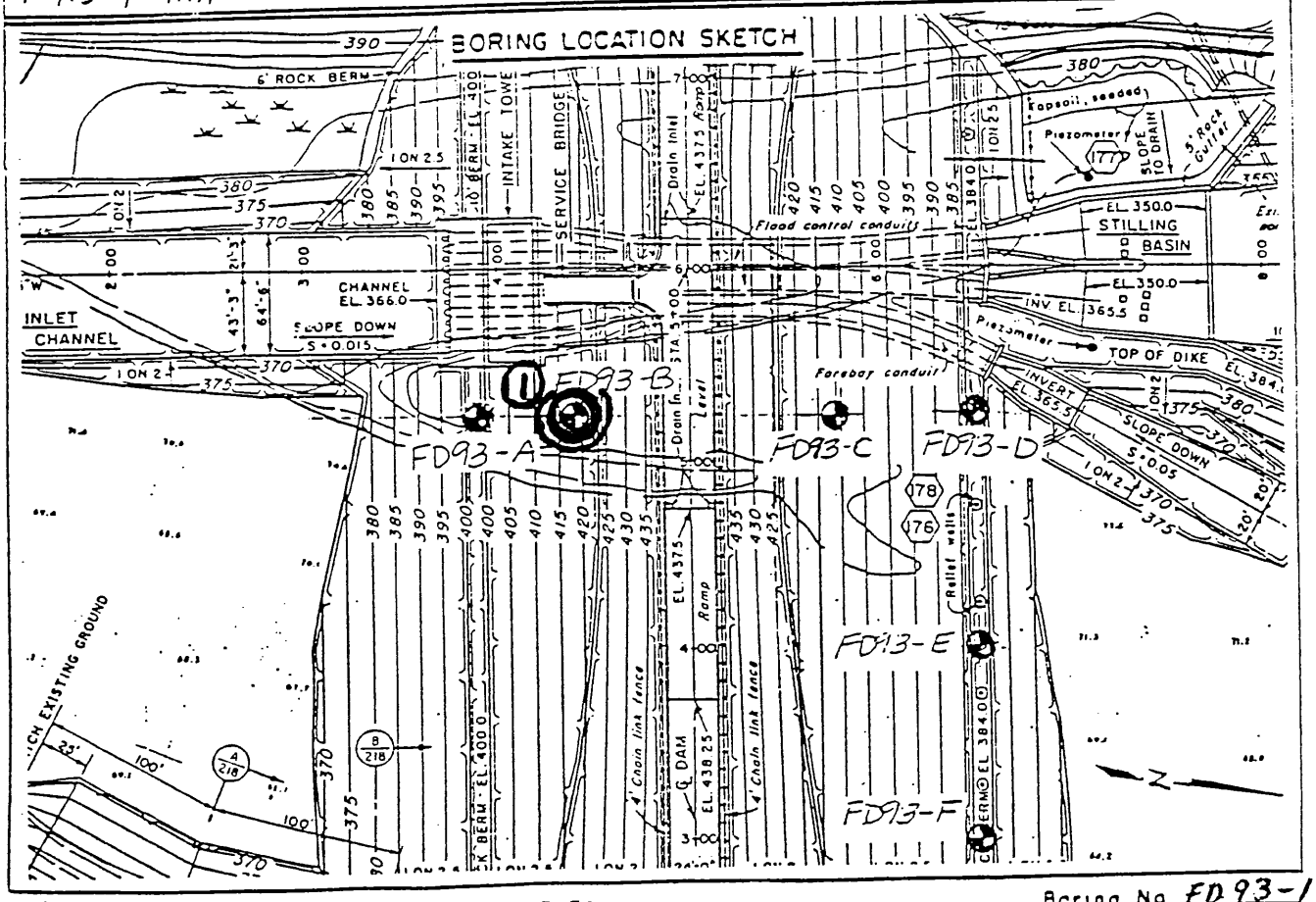
Boring No: FD 93-1

SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
10/5	700PM	20	26	5.5		INDUCED
10/6	700AM	20	26	5.5		
10/6	700PM	50	54	8.5		
10/7	730AM	50	54	8.9		
10/7	630PM	65	66	6.7		
10/8	700AM	65	66	12.5		
10/8	100PM	75	80	10.7		
10/11	1230PM	75	80	39.5		
10/11	700PM	84	88	14.1		INDUCED
10/12	700AM	84	88	29.8		
10/12	630PM	110	109	2.5		INDUCED
10/13	730AM	110	109	45.9		
10/13	630PM	120	128.5	30.7		INDUCED
10/14	730AM	120	128.5	47.5		
10/14	630PM	144.5	153.0	25.3		INDUCED

Note: Depths are in feet below original ground

10/15 700AM 144.5 153.0 45.5



PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 60' UPSTREAM | PIEZ NO.: 13-A

PIEZ TYPE: CASAGRANDE W 3/4" I.D PVC RISER | DEPTH OF PIEZ: 117' | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM TO GP-GM | SOIL SAMPLE NO.: S-46 TO S-54 | BORING DIAM: 4 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING | VENT: THREADED LOCKING CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.9 | ELEV PIEZ TIP: 299'

FILTER: #20 SILICA SAND | FROM ELEV: 297' | TO ELEV: 315'

SEAL: BELTONITE "PELLETS" | FROM ELEV: 291' 315' | TO ELEV: 297' 321'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T ELDRIDGE

DATE OF INSTALLATION: OCTOBER 18, 1993 | DATE OF OBSERVATIONS: NOVEMBER 11, 199

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 221	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
221 39	0.5	11.80	241	20.0	45.06			
222	1.0	19.06	251	30.0	45.72			
224	3.0	32.32						
226	5.0	37.70						
231	10.0	42.72						

REMARKS:

PIEZOMETRIC HEAD @ START OF TEST -46.62 FT.

Tom Eldridge
INSPECTOR

PLATE A.14

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 60' UPSTREAM | PIEZ NO.: 13-B

PIEZ TYPE: CASAGRANDE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: -48 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM | SOIL SAMPLE NO.: S-17 TO S-20 | BORING DIAM: 5 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING | VENT: threaded locking CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 418.0 | ELEV PIEZ TIP: 368'

FILTER: #20 SILICA SAND | FROM ELEV: 366' | TO ELEV: 374'

SEAL: BENTONITE "PELLETS" | FROM ELEV: 360' 374' | TO ELEV: 366' 378'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: OCTOBER 19, 1993 | DATE OF OBSERVATIONS: NOVEMBER 11, 199-

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 256	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
256 30	0.5	1.52	316	20.0	5.34			
257	1.0	2.10	326	30.0	6.18			
259	3.0	2.78						
301	5.0	3.26						
306	10.0	4.12						

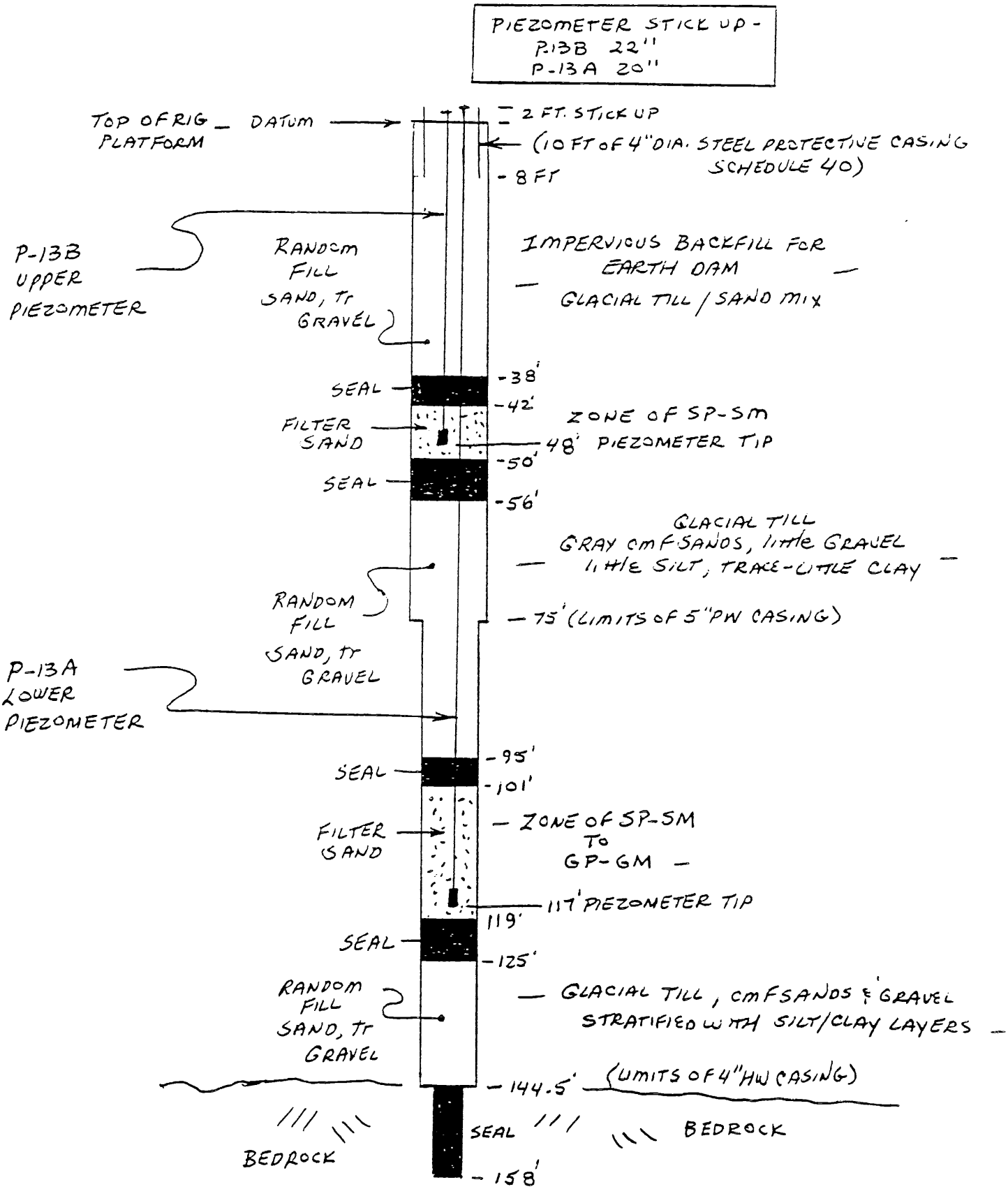
REMARKS:

PIEZOMETRIC HEAD @ START OF TEST -35.1 FT.

TOM ELDRIDGE
(INSPECTOR)

PLATE A.15

TEST BORING
FD 93-1



CASAGRANDE TYPE PIEZOMETERS
WITH 3/4" I.D. PVC RISERS
SCHEDULE 80

BENTONITE SEALS
#20 SILICA SAND - FILTER SAND
RANDOM FILL IS ALL PURPOSE SAND
60 lb BAGS & BANK RUN
SAND-GRAVEL

PLATE A.16

FIELD PERMEABILITY TEST RESULTS

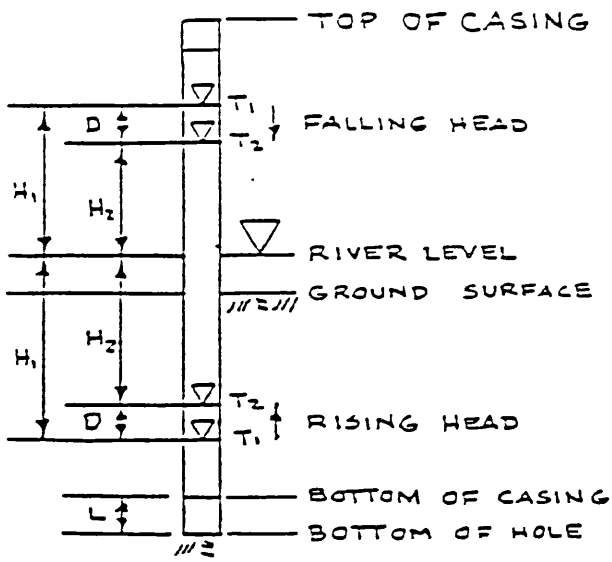
DATE: NOV 11, 1993	BORING No: FD93-1	DEPTH: 117 FT.	INSPECTOR: T ELDRIDGE

D_o = 1.0	D_i = 0.75	L = 216 IN.	H_1 = 46.62 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H	ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H
0.5	11.80	34.82	2.26×10^{-5}				
1.0	19.06	27.56	2.04×10^{-5}				
3.0	32.32	14.30	1.53×10^{-5}				
5.0	37.70	8.92	1.28×10^{-5}				
10.0	42.72	3.90	9.6×10^{-6}				
20.0	45.06	1.56	6.6×10^{-6}				
30.0	45.72	0.90	5.1×10^{-6}				

NOTES: PIEZOMETER 13-A

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING (
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
k_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{}{}$$

$$k_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} >$$

FIELD PERMEABILITY TEST RESULTS

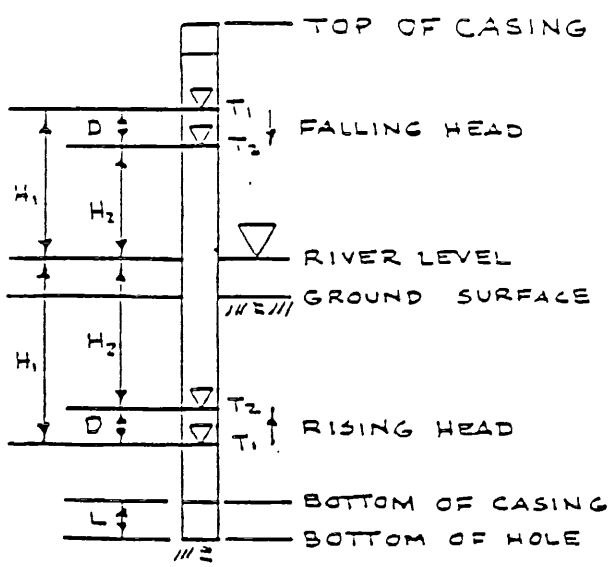
DATE: NOV 11, 1993	BORING NO: FD93-1	DEPTH: 48 FT.	INSPECTOR: T ELDRIDGE

D_o = 1.0	D_i = 0.75	L = 96 IN.	H_1 = 35.1 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H	ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H
0.5	1.52	33.58	6.8×10^{-6}				
1.0	2.10	33.0	4.7×10^{-6}				
3.0	2.78	32.32	2.1×10^{-6}				
5.0	3.26	31.84	1.5×10^{-6}				
10.0	4.12	30.98	9×10^{-7}				
20.0	5.34	29.76	6×10^{-7}				
30.0	6.18	28.92	5×10^{-7}				

NOTES: PIEZOMETER 13-B

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
K_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2}$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} >$$

PLATE A.18

CORPS OF ENGINEERS, U. S. ARMY
NEW ENGLAND DIVISION
FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

Site HOPKINTON DAM EXPLORATION PROGRAM PROJECT NO. DACW 33-93-D-0004

Page 1 of ___ Pages

Hole No. FD93-2 Diam. (Casing) 4"HW 5"PW

Boring Started OCTOBER 21, 1993

Co-ordinates: N 250997.22 E 478198.97

Boring Completed NOVEMBER 2, 1993

Drilled by ROB PRICE, DARIUS WINTERS (ATL)

Report Submitted ___

Purpose of Exploration TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTION AS WELL AS INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Top of Hole 416 NGVD

Total Overburden Drilled 142 Feet

Elevation Top of Rock 274 NGVD

Elevation Bottom of Hole 262 NGVD

Total Rock Drilled 12 Feet

Total Depth of Hole 154 Feet

Core Recovered 100 %

Core Recovered 10 Ft.: 0 Diam. 2-1 In.

Soil Samples 2 1/2 In. Diam. 37 No.

Soil Samples ___ In. Diam. ___ No.

Casing Left in Place 0 Feet

PIEZOMETERS PROTECTED WITH 10 FT. OF 4" DIA STEEL CASING (2 FT. STICK UP)

Water Table Depth -36 FT.

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	154	ROTARY-WASH

INDEX

Ground Water ___ Back of Page ___

Boring Location Sketch ___ Back of Page ___

Overburden Record ___ Page ___

Rock Drilling ___ Page ___

___ Page ___

___ Page ___

___ Page ___

Prepared by TOM [illegible] Field Data ___ Lab. Data

Submitted by ___

NED FORM DEC 63 121 REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

U. S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM Page 1 of 9 Pages

Boring No. FD93-2 Desig. FD93-~~B~~ C Diam. (Casing) 5"PW, 4"HW

Co-ordinates: N 250997.22 E 478198.97

Elevation Top of Boring 416 NGVD ~~M.S.L.~~ Hammer Wt. 300 lb Boring Started 10/21/93

Total Overburden Drilled 142 Feet Hammer Drop 18 IN. Boring Completed 11/2/93

Elevation Top of Rock 274 NGVD ~~M.S.L.~~ Casing Left

Total Rock Drilled 12 Feet Subsurface Water Data Page

Elevation Bottom of Boring 262 NGVD ~~M.S.L.~~ Obs. Well

Total Depth of Boring 154 Feet Drilled By ROB PRICE, DARIUS WINTERS

Core Recovered 100 % No. Boxes 1 Mfg. Des. Drill CME 55 TRUCK MOUNT

Core Recovered 10 Ft: – Diam. 2.1 In. Inspected By: T ELDRIDGE

Soil Samples 2½ In. Diam. 37 No. Classification By: T ELDRIDGE

Soil Samples In. Diam. No. Classification By:

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
403 OCT 21 10					ROLLER BIT (3⅞" DIA) & WASH TO -11 FT. REL. DIFFICULT DRILLING	(NS)
11	S-1		11.0 TO 13.0	18 24 19 27	300 lb. HAMMER 18 IN. DROP 2½" I.D. SPLIT SPOON NW ROD ROLLER BIT & WASH TO -15 FT.	Br. Silty (30-40) SAND W/little Gravel (5-15) (SM)
12						
13						
14					SPIN & WASH 5" CASING TO -15 FT.	(NS)
OCT 22 15	S-2		15.0 TO 17.0	15 35 27 34	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON SPIN & WASH 5" CASING TO -20 FT.	Br. Silty (30-40) SAND W/little-Gravel (5-15) (SM)
16						
17						
18						(NS)
19						
393 20						

GENERAL REMARKS:
BOREHOLE STARTED USING P-SIZE CORE BARREL INSIDE 4 IN. CASING, DRILLING THROUGH ROCK RIP-RAP. 5 IN. PW SIZE CASING W DIAMOND CUTTING SHOE WAS SPUN AND WASHED 10 FT.

ED ... 1.58 (Test)

Boring No. FD93-2

PLATE A.20

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
393	20	S-3		20.0 TO 22.0	33 30 23 25	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ADVANCE CASING, SPIN/WASH TO -25 FT.	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	21, 22, 23, 24						(NS)
	25	S-4		25.0 TO 27.0	41 30 46 37	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ADVANCE CASING, SPIN/WASH TO -30 FT. 3RD GEAR ½-¾ throttle MODERATE DRILLING	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	26, 27, 28, 29					ROLLER BIT & WASH CLEAN TO -30 FT DIFFICULT, SLOW DRILLING	(NS)
383	30	S-5		30.0 TO 32.0	20 23 25 33	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	31, 32, 33, 34					ROLLER BIT & WASH BOREHOLE TO -35 FT.	(NS)
378	35	S-6		35.0 TO 37.0	32 27 43 35	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
376	36, 37						

ED Form 58A (Test)

Boring No. F093-2

DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVT	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
376 / 37	S-7A		37.0 TO 39.0	34, 19, 13, 22	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON; SPIN & WASH CASING TO -39 FT.	Br. Well-graded SAND w/little Gravel (5-10) (SW)
38	S-7B					Br. Silty (30-40) SAND w/little Gravel (5-15) (SM) 38.5
OCT 25 374 / 39	S-8		39.0 TO 41.0	57, 68, 62, 71	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -41 FT.	Br. m-f SAND w/tr. Silt 39'
40, 41	S-9		41.0 TO 43.0	29, 43, 52, 60	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -43 FT	
42, 43	S-10		43.0 TO 45.0	22, 36, 63, 98	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -45'; SPIN & WASH PW CASING TO -45 3RD-4TH GEAR ½-¾ THROTTLE	(SP)
44, 45	S-11		45.0 TO 47.0	38, 47, 55, 72	300 lb HAMMER RELEASY 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON SAMPLER	
46, 47	S-12		47.0 TO 49.0	25, 41, 74, 202	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -49'	
48, 364 / 49	S-13		49.0 TO 51.0	43, 61, 42, 47	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; SPUN & WASHED PW CASING TO -50'	Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM) 49'
50, 51, 52					ROLLER BIT & WASH CLEAN TO -55 FT.	Poss. Cobbles (NS)
53, 359 / 54						

NED Form 58A (Test)

Boring No. FD93-2

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
359	51					ROLLER BIT & WASH TO -55 FT.	(NS)
	55	S-14		55.0 TO 56.3	36 80 100/3 (60%)	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; SPIN/WASH PW CASING TO -55'; MODERATE DRILLING	Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM)
	57					ROLLER BIT & WASH TO -60 FT. DIFFICULT @ TIMES	(NS)
	60	S-15		60.0 TO 61.6	52 88 99 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM)
26	62					ASSEMBLE & ADVANCE 4" HW CASING TO -65 FT.	(NS)
	64					ROLLER BIT & WASH TO -65 FT.	
	65	S-16		65.0 TO 67.0	95 84 135 142	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ADVANCE HW CASING TO -70 FT; CLEAN, WASH @ ROLLER BIT	COBBLE w/Dk. Gr. Silty (15-25) SAND (20-30) & little Gravel (0-10) (COBBLE)
	68						(NS)
	70	S-17		70.0 TO 71.8	41 30	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
342	71						

ED Form 58A (Test)

Boring No. FD93-2

DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVT	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
342 71	S-17		70.0 TO 71.9	88 100/3 (66%)	ROLLER BIT & WASH TO -73 FT. W/ NEW 3 7/8" BIT INSTALLED	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
72						
73						(NS)
74						
75	S-18		75.0 TO 76.2	79 136 120/2	300 lb HAMMER 18 IN. DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
76						
77					ADVANCE CASING TO -80 FT. ROLLER BIT & WASH TO -80 FT. RELATIVELY DIFFICULT DRILLING	
78						(NS)
79						
80	S-19		80.0 TO 80.3	150/3 (BOUNCE REF)	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
81					ADVANCE ROLLER BIT & WASH TO -85 FT. DIFFICULT DRILLING	
82						
83						(NS)
84						
85	S-20		85.0 TO 87.0	14 14 23 43	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON 86' SPIN/WASH HW CASING TO -85 FT.	Gr. Fat CLAY w/ SAND (10-20) (CH)
327 86						
87						
325 88					ROLLER BIT & WASH TO -90 FT.	(NS)

NED Form 58A (Test)

Boring No. FD 93-2

PLATE A.24

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
325	88						
	89					ROLLER BIT & WASH TO -90 FT. RELATIVELY EASY DRILLING	(NS)
	90	S-21		90.0 TO 91.2	40 TO 78 / 20/2 BOUNCING REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; SPIN & WASH HW CASING TO -90 FT. ROLLER BIT CLEAN TO -92 FT.	Gr. SILT W/f. SAND (15-25) (ML); (NS)
	92	S-22		92.0 TO 93.3	33 TO 90 / 120/4 BOUNCE REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ADVANCE CASING TO -95 FT.	Gr. SILT W/f. SAND (15-25) (ML)
	93					ADVANCE WITH ROLLER BIT & WASH TO -96 FT.	
	94						
	95					DRILLER NOTICE CHANGE 95.5'	(NS); (NS)
317	96	S-23		96.0 TO 96.5	58 TO 120/3 BOUN-REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT/WASH TO -98 FT.	Gr. m-f SAND W/Silt (5-15) & Gravel (10-20) (SP-SM); (NS)
OCT 27	97						
	98	S-24		98.0 TO 98.6	158 TO 70/1	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON	Gr. m-f SAND W/Silt (5-15) & Gravel (10-20) (SP-SM); (NS)
	99						
	100	S-25		100.0 TO 100.3	150/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; SPIN/WASH HW CASING CLEAN W/ ROLLER BIT & WASH	Silty, Clayey (12) SAND W/Gravel (16) (SC/SM); (NS)
	101						
	102	S-26		102.0 TO 102.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Subang. GRAVEL W/Sand (35-45) and Silt (5-15) (GP-GM); (NS)
	103						
	104	S-27		104.0 TO 104.3	120/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br., mostly C. SAND (SP)
308	105						

ED 58A (Test)

Boring No. FD 93-2

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
308	105					SPIN/WASH CASING TO -105 FT.	(NS)
	106	S-28		106.0 TO 106.2	150/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Mostly C. SAND (SP)
	107					ROLLER BIT & WASH TO -108 FT.	(NS)
305	108	S-29		108.0 TO 108.8	109/50/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (10-20) SAND w/Gravel (15-25) (SC)
	109					SPIN/WASH HW CASING TO -110 FT.	(NS)
	110	S-30		110.0 TO 110.9	90/150/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (13) SAND w/Gravel (22) (SC)
	111					ROLLER BIT & WASH BOREHOLE TO -112 FT.	(NS)
	112	S-31		112.0 TO 112.8	65/100/3 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (10-20) SAND w/tr. Gravel (SC)
	113					SPIN/WASH HW CASING TO -115 FT. 3RD GEAR - ¾ throttle	(NS)
	114						
298	115	S-32		115.0 TO 115.8	131/150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey, Silty (25-35) SAND w/Gravel (15-25) (SCSM)
	116						
	117					ADVANCE BORING USING ROLLER BIT & WASH 2ND GEAR ½-¾ throttle	(NS)
	118						
	119						
	120	S-33		120.0 TO 120.2	150/2 BOUNCING REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Well-graded SAND w/tr. Silt (SP)
	121					SPIN/WASH HW CASING TO -120 FT.	(NS)
291	122						

NED Form 58A (Test)

Boring No. FD93-2

PLATE A.26

	DEPTH (Ft.)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
291	122						
	123					ROLLER BIT & WASH ADVANCE TO -125 FT. RELATIVELY DIFFICULT DRILLING	(NS)
	124						
	125	S-34		125.0 TO 125.1	175 100/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (20-30) SAND w/Gravel (5-15) (SM)
OCT 28	126						
	127					ROLLER BIT & WASH ADVANCING TO -130 FT.	(NS)
	128						
	129						
	130	S-35		130.0 TO 130.2	130/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. SAND w/Silt (5-15) (SP-SM)
	131						
	132					ROLLER BIT & WASH TO -135 FT.	(NS)
	133						
	134						
	135	S-36		135.0 TO 135.3	250/3 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Silty (15-25) SAND (SM)
	136						
	137					SPIN & WASH CASING TO -137 FT. MODERATE TO SLOW 3RD GEAR ½-¾ throttle	(NS)
	138						
274	139						

Form 58A (Test)

Boring No. FD93-2

	DEPTH (ft)	CORE/SAMPLE No.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
274	139					ROLLER BIT & WASH ADVANCE TO -140 FT.	(NS)
	140	S-37		140.0 TO 141.3	60 90 12 5/4	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Sr. CLAY (CL)
	141					ROLLER BIT & WASH TO -142 FT. "BEDROCK ENCOUNTERED	
	142					CONTINUE ROLLER BIT -2 FT. IN TO ROCK ADVANCE HW CASING TO -142 FT.	Granite Bedrock (NS)
	143						
	144						
	145				R-1 60" REC 100% RQD 33 1/3	CORE ROCK WITH NX SIZE CORE BARREL, DIAMOND BIT RUN-1 DRILL TIME: 14 MIN. CORE ROCK BETWEEN -144 FT. TO -149'	Granite Bedrock w/a few seams beaded sandstone
	146						
	147						
	149						
	149						
263	150				R-2 60" REC 100% RQD 92	RUN-2 NX SIZE CORE BARREL, with DIAMOND BIT DRILL TIME: 24 MIN. CORE ROCK BETWEEN -149' TO -154'	Granite Bedrock sandstone seams
	151						
	152						
	153						
259	154					TERMINATE BORING @ -154 FT.	

Form 58A (Test)

Boring No. FD 93-2

FIELD LOG OF TEST BORING IN ROCK

SITE HOPKINTON DAM HOLE NO. FD 93-2 PAGE 2

	DATE	DEPTH FT. FROM	DEPTH FT. TO	RUN FT.	RUN REC'V'Y FT.	REC'V'Y %	DRILLING BEHAVIOR: FEED	DRILLING BEHAVIOR: WATER	DRILLING BEHAVIOR: REASON FOR PULL	ACTUAL DRILLING TIME	BIT NO. SIZE AND TYPE	ADDITIONAL REMARKS
R-1	OCT 28	144.0	149.0	5 FT.	5 FT	100%		NO WATER LOSS		14 MIN.	NX CORE DIAMOND	RQD=33 WEATHERED GRANITE
R-2	OCT 28	149.0	154.0	5 FT.	5 FT.	100%				24 MIN.	NX CORE DIAMOND	RQD=92 GRANITE (SANDSTONE SEAMS)

TOTAL BED ROCK DRILLED 10 FEET

TOTAL BED ROCK RECOVERED 10 FEET

BED ROCK RECOVERY 100 PERCENT

DRILLER ROB PRICE

INSPECTOR TOM ELDRIDGE

HED FORM DEC 61 130

C-56

PLATE A.29

Site: HOPKINTON DAM

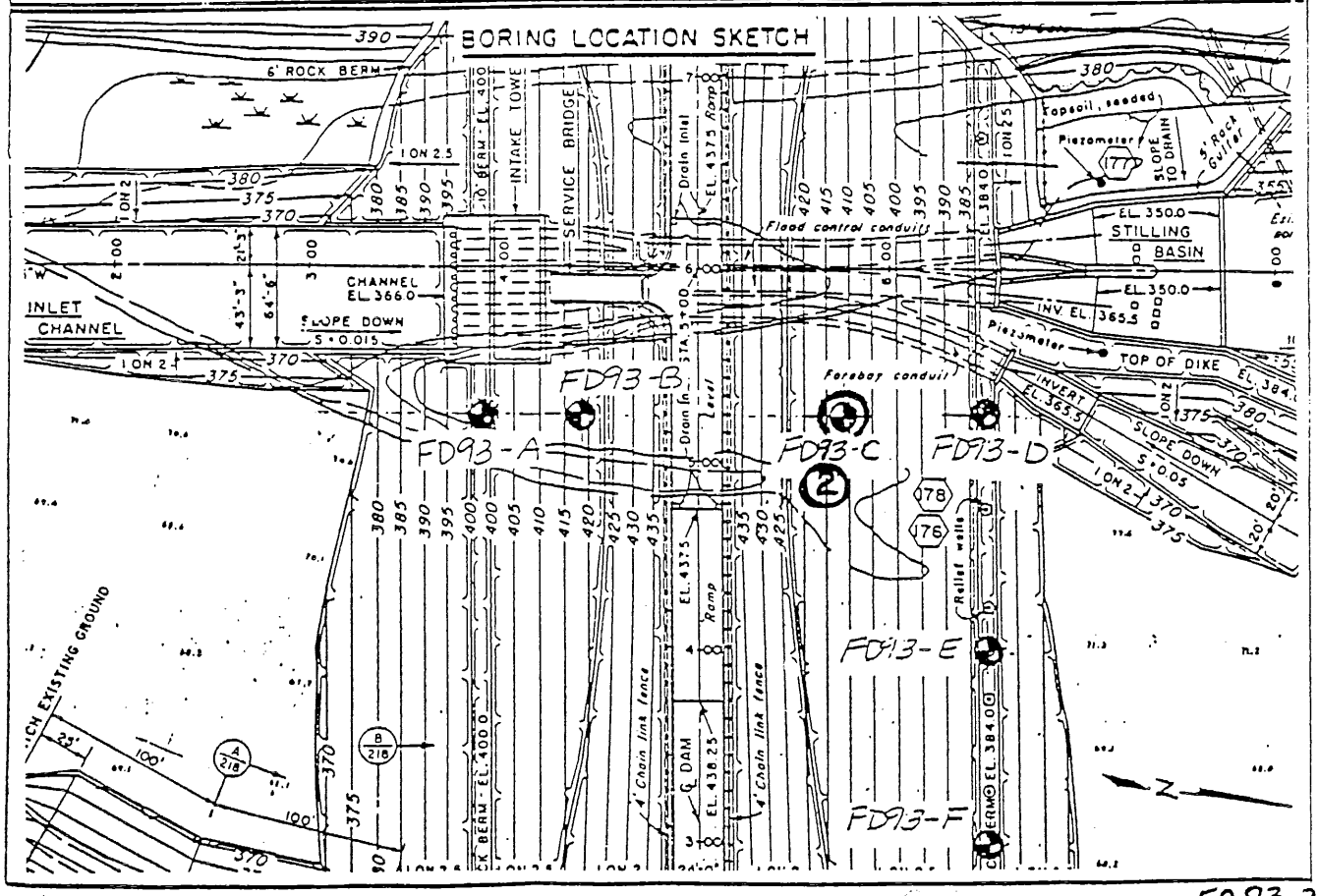
Boring No: FD93-2

SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
10/25	1230PM	39	39	34.2		
10/25	630AM	55	62	12.2		(INDUCED)
10/26	700AM	55	62	34.5		
10/26	615PM	95	97	25.5		(INDUCED)
10/27	715AM	95	97	35.5		
10/27	600PM	120	126	25.8		(INDUCED)
10/28	715AM	120	126	37.5		
10/28	600PM	142	154	24.3		(INDUCED)

Note: Depths are in feet below original ground

BORING LOCATION SKETCH



PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM EXPLORATION PROGRAM | DATE. NOVEMBER 2, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 75' DOWNSTREAM | PIEZ NO.: 14-A

PIEZ TYPE: CASAGRADE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: -113 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM | SOIL SAMPLE NO.: S-23 TO S-31 | BORING DIAM: 4"

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" STEEL CASING | VENT: THREADED LOCKING CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.8' | ELEV PIEZ TIP: 303'

FILTER: #20 SILICA SAND | FROM ELEV: 301' | TO ELEV: 320'

SEAL: PELTONITE PELLETS | FROM ELEV: 295' 320' | TO ELEV: 301' 326'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 2, 1993 | DATE OF OBSERVATIONS: NOV 2, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 205	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
2053	0.5	8.75	225	20.0	43.14			
206	1.0	13.45	235	30.0	43.66			
208	3.0	25.90						
210	5.0	32.82						
215	10.0	40.14						

REMARKS:

PIEZOMETRIC HEAD @ -49.22 FT. @ START OF TEST

TOM ELDRIDGE
INSPECTOR

PLATE A.31

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM EXPLORATION PROGRAM | DATE. NOVEMBER 2, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 75' DOWNSTREAM | PIEZ NO.: 14-B

PIEZ TYPE: CASAGRANDE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: -47 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP | SOIL SAMPLE NO.: S-8 TO S-12 | BORING DIAM: 5 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" STEEL CASING | VENT: threaded locking cap

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.9' | ELEV PIEZ TIP: 369'

FILTER: #20 SILICA SAND | FROM ELEV: 367' | TO ELEV: 377'

SEAL: BENTONITE PELLETS | FROM ELEV: 361' 377' | TO ELEV: 367' 383'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 2, 1993 | DATE OF OBSERVATIONS: NOV 2, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 241	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
2 47 30	0.5	19.30	307	20.0	35.22			
248	1.0	23.75	317	30.0	35.70			
250	3.0	30.32						
252	5.0	32.35						
257	10.0	34.16						

REMARKS:

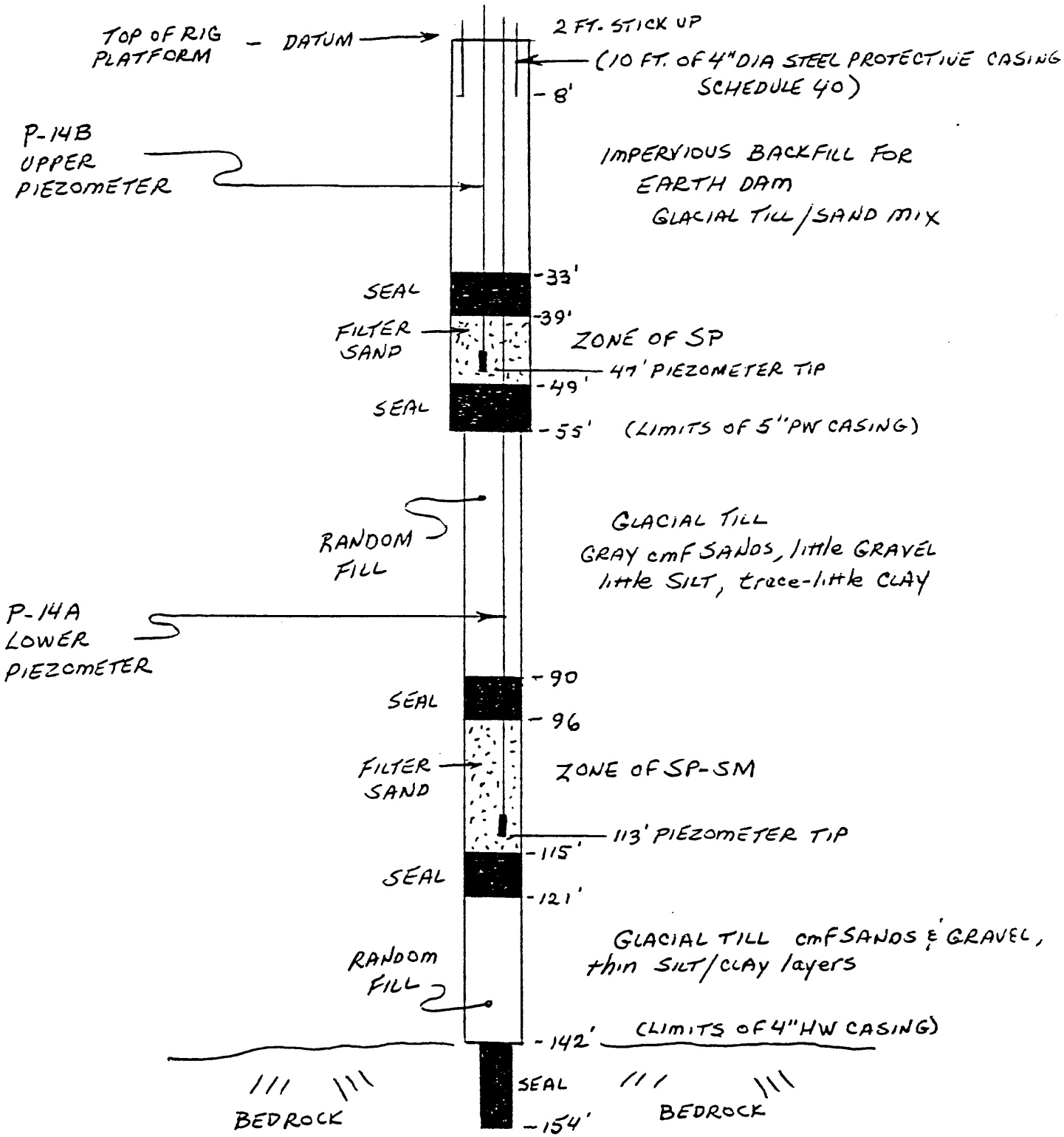
PIEZOMETRIC HEAD @ -37.44 FT. @ START OF TEST

Tom Eldridge
INSPECTOR

PLATE A.32

TEST BORING
FD 93-2

PIEZOMETER STICK UP -
P-14B - 22 IN.
P-14A - 20 IN.



CASAGRANDE TYPE PIEZOMETERS
WITH 3/4" I.D. PVC RISERS
SCHEDULE 80

BENTONITE SEALER - PELTONITE "PELLETS"
FILTER SAND - #20 SILICA SAND
RANDOM FILL - ALL PURPOSE SAND
60 lb BAGS

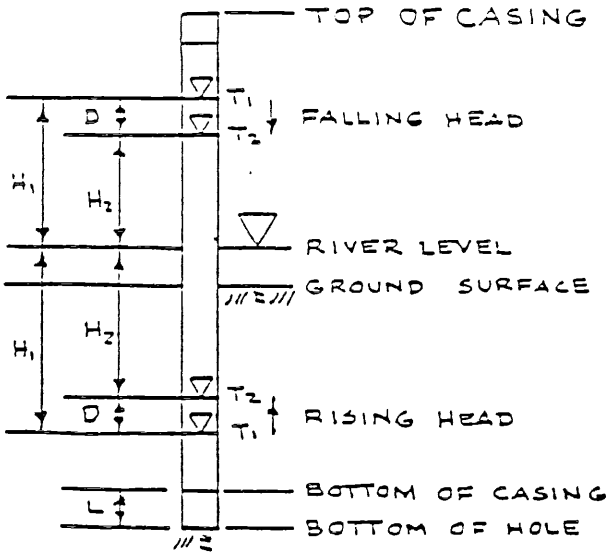
FIELD PERMEABILITY TEST RESULTS

DATE: 11/2/93	BORING NO: FD93-2	DEPTH: ~49 FT.	INSPECTOR: TE
D_o = 1.0 IN.	D_i = 0.75 IN.	L = 120 IN.	H_1 = 37.44 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME $(t_2 - t_1)$ MIN	ΔD $(H_2 - H_1)$	H_2 FT $(H_1 - D)$	K_H IN/SEC	ELAPSED TIME $(t_2 - t_1)$	ΔD $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H
0.5	-19.30	18.14	9.31×10^{-5}				
1.0	-23.75	13.69	6.46×10^{-5}				
3.0	-30.32	7.12	3.55×10^{-5}				
5.0	-32.35	5.09	2.56×10^{-5}				
10.0	-34.16	3.28	1.56×10^{-5}				
20.0	-35.22	2.22	9.0×10^{-6}				
30.0	-35.70	1.74	6.5×10^{-6}				

NOTES: PIEZOMETER 14-B
MINUTES AND FEET WERE CONVERTED TO SECONDS AND INCHES FOR HORIZONTAL PERMEABILITY COEFFICIENT

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING (
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
K_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} >$$

CORPS OF ENGINEERS, U. S. ARMY
NEW ENGLAND DIVISION
FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

PROJECT NO. DACW33-93-D-0004

Site HOPKINTON DAM

Page 1 of ___ Pages

Hole No. FD 93-3 Diam. (Casing) 4"HW 5"PW

Boring Started NOVEMBER 3, 1993

Co-ordinates: N 251074.22 E 478166.43

Boring Completed NOVEMBER 11, 1993

Drilled by ATLANTIC TESTING LABS

Report Submitted ___

Purpose of Exploration TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTIONS, AND INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Top of Hole 384 NGVD

Total Overburden Drilled 124 Feet

Elevation Top of Rock 260 NGVD

Elevation Bottom of Hole 249 NGVD

Total Rock Drilled 11 Feet

Total Depth of Hole 135 Feet

Core Recovered 100 %

Core Recovered 10 Ft.: – Diam. 2.1 In.

Soil Samples 2 1/2 In. Diam. 29 No.

Soil Samples ___ In. Diam. ___ No.

Casing Left in Place 0 Feet

PIEZOMETERS PROTECTED WITH 5 FEET 4" DIA STEEL CASING (GROUTED IN HOLE)

Water Table Depth -3.5 FT

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	135	ROTARY-WASH BORING

INDEX

Ground Water	Back of Page ___
Boring Location Sketch	Back of Page ___
Overburden Record	Page ___
Rock Drilling	Page ___
	Page ___
	Page ___
	Page ___

Prepared by TOM ELDRIDGE
Field Data

Lab. Data

Submitted by ___

NED FORM DEC 63 121

REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

PLATE A.36

U. S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM, Page 1 of 8 Pages

Boring No. FD93-3 Desig. FD93-D Diam. (Casing) 5" PW

Co-ordinates: N 251074.22 E 478166.43

Elevation Top of Boring 384 NGVD ~~MSL~~
Total Overburden Drilled 124 Feet
Elevation Top of Rock 260 ~~MSL~~
Total Rock Drilled 11 Feet
Elevation Bottom of Boring 249 ~~MSL~~
Total Depth of Boring 135 Feet
Core Recovered 100 % No. Boxes 1
Core Recovered 10 Ft. — Diam. 2.1 in.
Soil Samples 2 1/2 in. Diam. 29 No.
Soil Samples ____ in. Diam. ____ No.

Hammer Wt. 300 lb Boring Started NOV 3, 1993
Hammer Drop 18 IN
Casing Left ____ Boring Completed NOV 11, 1993
Subsurface Water Data ____ Page ____
Obs. Well ____
Drilled By ROB PRYCE, DARIUS WINTERS
Mfg. Des. Drill CME 55 TRUCKMOUNT
Inspected By: T ELDRIDGE
Classification By: T ELDRIDGE
Classification By: ____

	DEPTH 1's	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
NOV 3 384						0-8 FT ROCK RIP RAP CHANGE 0-8 FT. BEGIN SAMPLE 0-10 FT.	(NS)
374	10	S-1		10.0 TO 12.0	6 6 4 4	300 lb HAMMER 18 IN. DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Br. m-f SAND (SP)
NOV 4	11					SPIN & WASH PW CASING TO -15 FT. EASY DRILLING	
	12						
	13						(NS)
	14						
	15	S-2		15.0 TO 17.0	4 3 3 5	300 lb HAMMER 18 IN. DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Br. m-f SAND w/trace Gravel (SP)
	16					SPIN & WASH PW CASING TO -20 FT. 3RD-4TH GEAR 3/4 throttle	
	17						
	18					DRILLING CHANGE	(NS)
	19						

GENERAL REMARKS:
ADVANCED BORING THROUGH ROCK RIP RAP
A 3 7/8" ROLLER BIT WAS USED TO PENETRATE AND BREAK THROUGH ROCK / 10 FT. OF PW SIZE CASING WAS ADVANCED

ED MAR 58 (Test)

Boring No. FD93-3

PLATE A.37

	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
	19					INSTALL ROLLER BIT CLEAN WASH PW CASING TO -20 FT.	(NS)
364	20	S-3		40 / 80 / 80 / 130	20.0 TO 22.0	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (30-40) SAND (SC/SM)
	21					ROLLER BIT & WASH TO -25 FT. 2ND GEAR ½-¾ throttle	
	22						
	23						(NS)
	24						
	25	S-4		45 / 50½	25.0 TO 25.7	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (25-35) SAND within beds of Varved Clay (20-30) (SC)
	26					REPLACE SAN SHOE ON 4" PW CASING	
	27					SPIN CASING TO -30 FT.	
	28					CLEAN/WASH W ROLLER BIT TO -30 FT.	(NS)
	29						
	30	S-5		30.0 TO 32.0	33 / 57 / 88 / 97	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (30-40) SAND (SC/SM)
	31					HW SPIN/WASH CASING TO -35 FT MODERATE DRILLING	
	32						
	33						(NS)
	34						
	35	S-6		35.0 TO 37.0	21 / 32	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty, Clayey (30-40) SAND (SC/SM)
348	36						

NED Form 58A (Test)

Boring No. FD 93-3

PLATE A.38

DEPTH	1"	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
348 36		S-6		35.0 TO 37.0	34 40	ADVANCE HW CASING AND ROLLER BIT/WASH TO -40 FT.	Dk. Gr. Silty, Clayey (30-40) SAND (SC/SM)
37							
38							
39							(NS)
40		S-7		40.0 TO 42.0	55 63 68 61	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. CLAY W/Sand (30-40) & tr. Gravel (CL)
41							
42						ROLLER BIT & WASH TO -45 FT.	
43							
44							(NS)
45		S-8		45.0 TO 47.0	52 70 65 71	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Clayey, Silty (30-40) SAND w/tr. Gravel (SC/SM)
46							
47							Nested Cobbles & Boulders
48							
49						ROLLER BIT & WASH TO -50 FT. ADVANCE 4" CASING TO -50 FT.	Cobbles
50		S-9A					
51				50.5 TO 52.5	72 57 21 19	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Subang. GRAVEL W/Sand (10-20) (GP)
52		S-9B					
331 53							Lt. Gr. Varved CLAY (CH)

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Boring No. FO 93-3

PLATE A.39

	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
331	53						
	54					ADVANCE BORING WITH ROLLER BIT / WASH TO -55 FT.	(NS)
	55	S-10A		55.0 TO 57.0	55,19 31 49 130	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLITSPOON	Lt. Br. m-f SAND w/tr. Silt (SP)
	56						
	57	S-10B					Lt. Br. f. SAND within pockets of varied Clay (25-35) (SP)
	58					ADVANCE HW CASING TO -60 FT.	
	59					ROLLER BIT & WASH TO -60 FT.	(NS)
	60	S-11		60.0 TO 60.8	100 100/4 REF	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLITSPOON	Br. Silty (15-25) m-f SAND w/little Gravel (0-10) (SM)
	61					ROLLER BIT/WASH TO -65 FT.	
	62						
	63						(NS)
	64						
	65	S-12		65.0 TO 65.8	70 50/4	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLITSPOON	Br. Silty, Clayey (23) SAND w/few Gravel (14) (SC/SM)
	66						
	67					SPIN/WASH HW CASING TO -65 FT.	
	68					EASY TO MOD. DIFFICULT WHERE COBBLES ARE ENCOUNTERED	(NS)
	69					1/2 3/4 THROTTLE 3RD 4TH GEAR	
314	70						

ED Form 58A (Test)

Boring No. FD93-3

PLATE A.40

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
314 Nov 5	70	S-13		70.0 TO 70.8	135 / 100/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON MC SAND IN CUTTINGS FROM ROLLER BIT @ -70 FT.	Br. Silty, Clayey (10-20) SAND w/ Subang. Gravel (15-25) (SC/SM)
	71						
	72					SPIN/WASH HW CASING TO -75 FT. MODERATE DRILLING CLEAN WITH ROLLER BIT	
	73						(NS)
	74						
	75	S-14		75.0 TO 75.1	80/1 BACKING REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT & WASH TO -80 FT. ½-¾ throttle 2ND GEAR VARYING TO CONDITION	Br. well-graded SAND w/ Rock Frags (40-50) (SW)
	76						
	77						
	78						(NS)
	79						
	80	S-15		80.0 TO 81.2	60 / 114 / 100/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON ROLLER BIT THEN ADVANCE CASING TO -85 FT. WASH BORING ↓	80' Gr. Varved CLAY w/ m-f Sand (15-25) (CL)
	81						
	82						
	83						(NS)
	84						
	85	S-16		85.0 TO 85.4	150 / 5 REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	85' Olive Gr. Silty (15-25) SAND w/ little Gravel (0-10) (SM)
Nov 8	86						(NS)
297	87						

NED Form 58A (Test)

Boring No. FD 93-3

	DEPTH (ft)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
291	87	S-17		87.0 TO 87.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (15-25) SAND w/little Gravel (0-10) (SM)
	88					ROLLER BIT & WASH TO -90 FT.	
	89						(NS)
	90	S-18		90.0 TO 90.8	119 150/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (15-25) SAND w/little Gravel (0-10) (SM)
	91					ADVANCE BORING BY ROLLER BIT/WASH TO -94 FT.	
	92						(NS)
	93						
290	94	S-19		94.0 TO 94.2	95/2 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Lt. Br. Silty, Clayey (30-40) w/little Gravel (0-10) (SC/SM)
	95					ROLLER BIT/WASH TO -96 FT.	(NS)
	96	S-20		96.0 TO 96.4	130/3 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Lt. Br. Silty, Clayey (30-40) SAND w/ little Gravel (0-10) (SC/SM)
	97					ROLLER BIT/WASH TO -98 FT.	(NS)
286	98	S-21A		98.0 TO 98.8	80 99/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	COBBLES & BOULDERS w/Sand (25-35) & Clay Pockets (15-25) 98.5
285	99	S-21B				ROLLER BIT/WASH TO -100.5 FT.	Olive Clayey (30-40) SAND w/Gravel (10-20) (SC)
	100						(NS)
	101	S-22		100.5 TO 101.3	75 92/3	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Clayey (30-40) SAND w/Gravel (10-20) (SC)
NOV 9	102						
	103						(NS)
280	104						

ED Form 58A (Test)

Boring No. ED93-3

PLATE A.42

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
280 / 104					ROLLER BIT & WASH TO -105 FT.	(NS)
105	S-23		105.0 TO 107.0	26 49 111 102	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Br. CLAY w/lt. gr. Silt Laminations (CL)
106						
107					ROLLER BIT & WASH TO -110 FT. HOLE STAYS OPEN	(NS)
108						
109						
110	S-24		110.0 TO 111.4	47 65 150/5	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (40-50) SAND (SC/CL)
111						
112					ROLLER BIT & WASH TO -115 FT. HOLE PLUGS / CLEAN OUT W ROLLER BIT ADVANCE HW CASING, SPIN/WASH TO -115 FT.	(NS)
113						
114						
115	S-25		115.0 TO 117.0	49 65 84 135	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (40-50) SAND (SC/CL)
116						
117					ROLLER BIT & WASH TO -120 FT. 2ND GEAR ½-¾ throttle	(NS)
118						
119						
120	S-26		120.0 TO 120.4	150/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (20-30) SAND w/lithic Gravel (0-10) SM
263 / 121						

Nov 9

NED Form 58A (Test)

Boring No. FD93-3

	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
263	121					ROLLER BIT/WASH TO -124 ±	
	122					SPIN/WASH HW CASING TO -125 FT - SEAT IN TO ROCK	
	123						COBBLES/ BOULDERS (NS)
260	124						
259	125						BEDROCK (NS)
	126				R-1 60" REC 100%	CORE ROCK WITH NX SIZE CORE BARREL, DIAMOND BIT RUN-1 (5 FT) DRILLING TIME 15 MIN. - NO WATER LOSS -	
	127				RQD 93		
	128						
	129						WEATHERED GRANITE BEDROCK
	130				R-2 60" REC 100%	RUN-2 (5 FT) DRILLING TIME 10 MIN 30 SEC. - NO WATER LOSS	
	131						
	132						
	133				RQD 60		
	134						
249	135					BORING TERMINATED @ -135'	

ED Form 58A (Test)

Boring No. FD 93-3

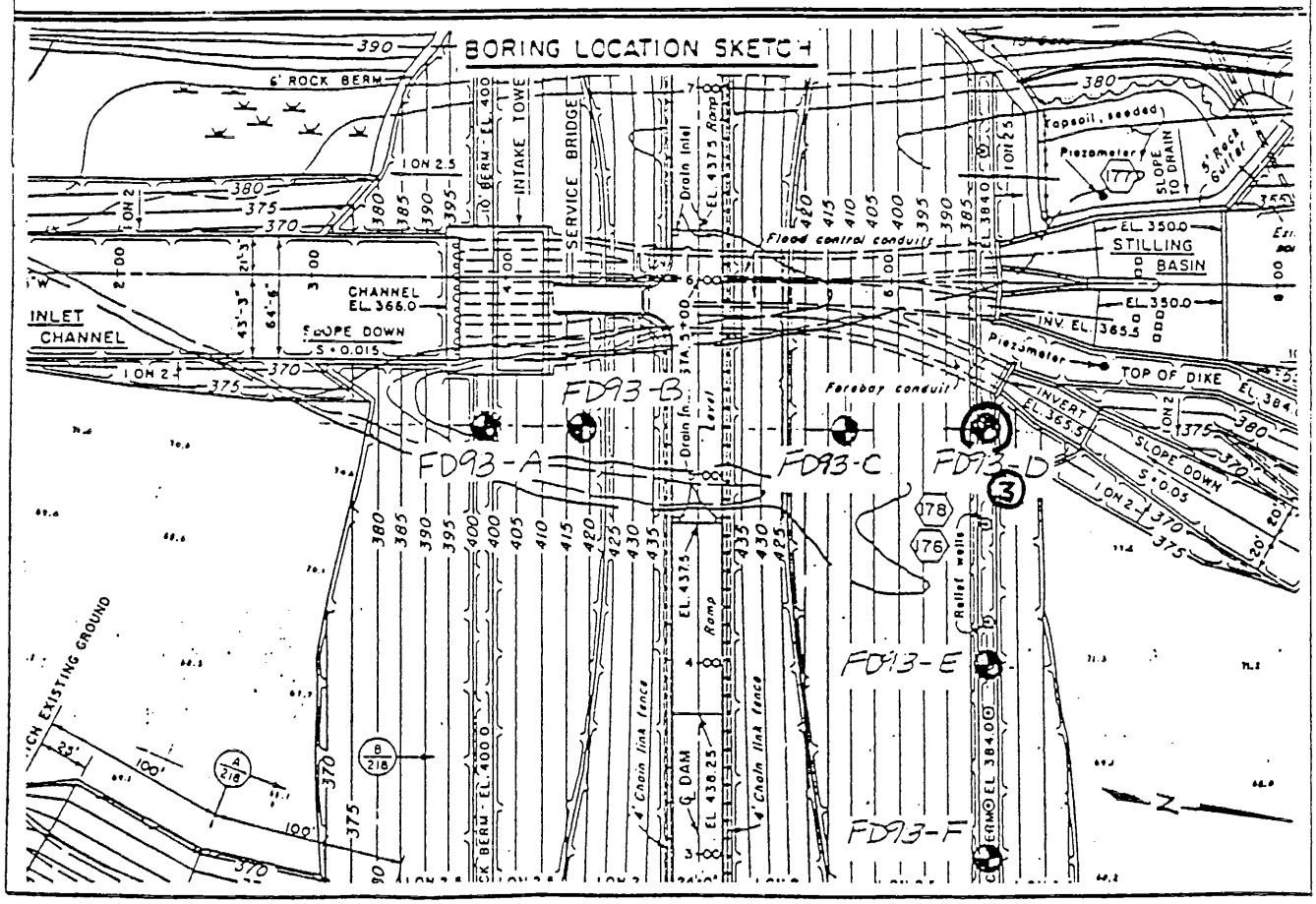
Site: HOPKINTON DAM

Boring No: FD93-3

SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
11/5	630AM	70	66	-3.2'		
11/5	1230PM	85	85	-10.5'		(INDUCED)
11/8	1200	85	85	-14.5'		
11/8	500PM	85	101	-12.3'		(INDUCED)
11/9	630AM	85	101	-6.6'		
11/9	500PM	125	135	-18.0'		(INDUCED)
11/10	630AM	125	135	-15.9'		

Note: Depths are in feet below original ground



PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 150' DOWNSTREAM | PIEZ NO.: PZ-15

PIEZ TYPE: CASAGRANDE @ 3/4" I.D PVC RISER | DEPTH OF PIEZ: -83 FEET | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM STRATIFIED | SOIL SAMPLE NO.: S-9A TO S-15 | BORING DIAM: 4"

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING | VENT: Threaded locking CAP

GROUND ELEV.: 384' (NGVD) | ELEV. TOP OF RISER: 384.3' | ELEV PIEZ TIP: 301'

FILTER: #20 SILICA SAND | FROM ELEV: 299' | TO ELEV: 334'

SEAL: BELTONITE "PELLETS" | FROM ELEV: 293' 334' | TO ELEV: 299' 340'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 10, 1993 | DATE OF OBSERVATIONS: NOVEMBER 11, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 1019	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
1019 30	0.5	3.28	1039	20.0	—			
1020	1.0	4.69	1049	30.0	—			
1022	3.0	5.74						
1024	5.0	5.80						
1029	10.0	5.80						

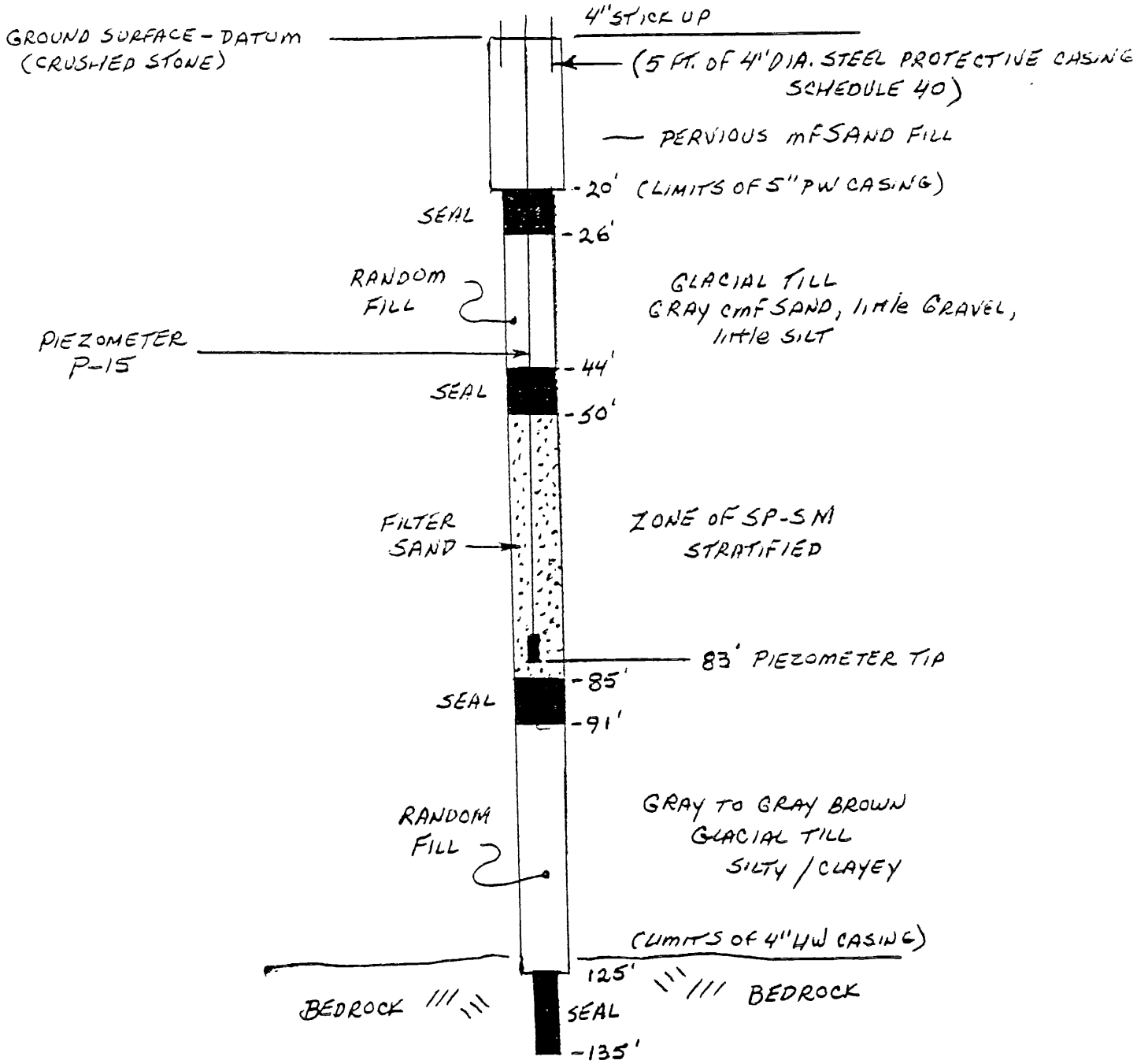
REMARKS:

- PIEZOMETRIC HEAD @ START OF TEST -5.90 FT.
- THE AVERAGE OF 2 RUNS WITH SIMILAR RESULTS EACH RUN

Tom Eldridge
INSPECTOR

PLATE A.46

TEST BORING
FD 93-3



CASAGRANDE TYPE PIEZOMETER
WITH 3/4" I.D. PVC RISER
SCHEDULE 80

BENTONITE SEALER - PELTONITE "PELLETS
FILTER SAND - #20 SILICA SAND
RANDOM FILL - #4 SILICA SAND

FIELD PERMEABILITY TEST RESULTS

DATE: NOV 11, 1993	BORING NO: FD93-3	DEPTH: 83 FT.	INSPECTOR: T ELDRIDGE

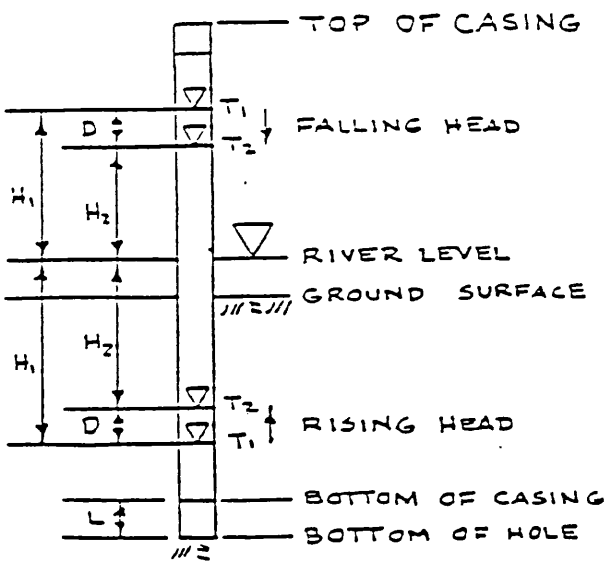
D_o = 1.0	D_i = 0.75	L = 420 IN.	H_1 = 5.90 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H	ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 ($H_1 - D$)	K_H
0.5	3.28	2.62	3.54×10^{-5}				
1.0	4.69	1.21	3.46×10^{-5}				
3.0	5.74	0.16	2.62×10^{-5}				
5.0	5.80	0.10	1.78×10^{-5}				
10.0	5.80	0.10	8.9×10^{-6}				
20.0			—				
30.0			—				

NOTES: PIEZOMETER 15

EXPERIENCED MORE DOWNHOLE PRESSURE IN THIS BORING COMPARED TO OTHERS WHEN SETTING PIEZOMETER

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING (C
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
k_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{}{}$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} > 1$$

Standard 1

The following standards and procedures are employed for Crest Monument Surveys at Hopkinton Lake Dam.

STANDARDS FOR SETTLEMENT SURVEYS

1. Control points are stamped brass disks preferably set in a ledge area. Where no ledge is available, they are set in concrete bounds placed flush with the ground.

2. Control points are set in areas such that the maximum possible number of crest monuments on the dam are visible.

3. Control points are tied into four reference points by distance. This provides a check each time they are occupied for settlement surveys or allow them to be replace if found to be destroyed.

4. Distances are read and recorded between settlement bounds. Both distance and angle are read and recorded from the control points that are being occupied to locate each settlement bound on the dam.

5. In locating each settlement bound, a control point will be occupied setting 0-00'-00" (referenced line of site) on a second control point, reading and recording both interior and exterior angle closure, along with distances through each settlement bound located on the dam. Each settlement bound is located from a minimum of two control points. These locations are third order, class II survey with relative accuracies of not less than 1 part in 5,000.

6. Levels are run from control points through each settlement bound on the dam with a return run back into the control points to check the elevation closure on the run. Closure tolerance should be no greater than 0.05'. These levels are third order, class I survey with relative accuracies not less than 1 part in 10,000.

7. Crest monument surveys are performed using Topcon EDM Total Stations and recording both horizontal angles and horizontal distances.

PROCEDURE FOLLOWED FOR SETTLEMENT SURVEYS

The horizontal and vertical monitoring plan for settlement bound movement points employed a combination of triangulation and trilateration angle and distance techniques to survey the control network. Control points, in the form of stamped brass disks, were placed on the dam structure in a location that is clearly

visible from the control points. Horizontal coordinates of the control points are based on the State Plane Coordinate System. Elevations of the control points are bawd on the National Geodetic Vertical Datum (NGVD). Control points are occupied utilizing an EDM Total Station; observed distances and angles (interior and exterior angles), between control points and settlement bound establishing permanent bench marks. Standard leveling techniques are followed. Levels are double run and the means of the front and back runs were computed and recorded.

DATA ADJUSTMENT

A combination of triangulation and trilateration surveying techniques are applied. Each crest monument is located from two control points and two sets of coordinates are calculated using adjusted field angles and compliments and EDM distances. The two sets of coordinates are averaged to give a net result. The averaged coordinates are then established on each settlement bound for use in determining shifts in the dam surface structure over a period of years by comparing repetitive surveys.

HOPKINTON DAM
MERRIMACK RIVER BASIN

Reading Schedule for Piezometers

General. Piezometers are utilized to measure groundwater levels and pore pressures both in the foundation and embankments of earth and rockfill dams. Experience has shown that installation of piezometers in earth fills and their foundation provides significant data indicating the magnitude and distribution of pore pressures and their variations with time and also patterns of seepage, zones of potential piping, and the effectiveness of underseepage control measures.

2. Piezometer Readings. At the present time, files are maintained for dams which have operating piezometers and most of the data is put on the computer. Data is transmitted to GEB in writing by the project manager. Piezometer data should be reduced in the field and each reading compared with previous data; thus, if a piezometer has an unusual reading, the reading can be checked immediately. Pool elevations, tailwater elevations, measuring weir discharge quantities, and rainfall data should be recorded simultaneously with piezometer readings.

a. Reading Schedules.

(1) Routine. During periods when the reservoir is at or below the 22 foot stage (Elev 388) readings should be made by the project manager at least once a month. When access to instruments is made hazardous by snow or ice, the readings may be deferred until safe access is possible.

(2) High Pool. During periods when the reservoir level (includes rising and falling pools) is above the 22 foot stage, readings should be made on a daily basis. Pool elevations and all the other information requested in paragraph 2 above should be recorded simultaneously with piezometer readings. On a falling pool, piezometer readings should continue for approximately five days after the pool has returned to its normal elevation.

b. Data Collection.

(1) Location Maps. A general plan of the project showing the location of the active piezometers and the corresponding identification number for each piezometer is provided to eliminate identification and data recording inaccuracies.

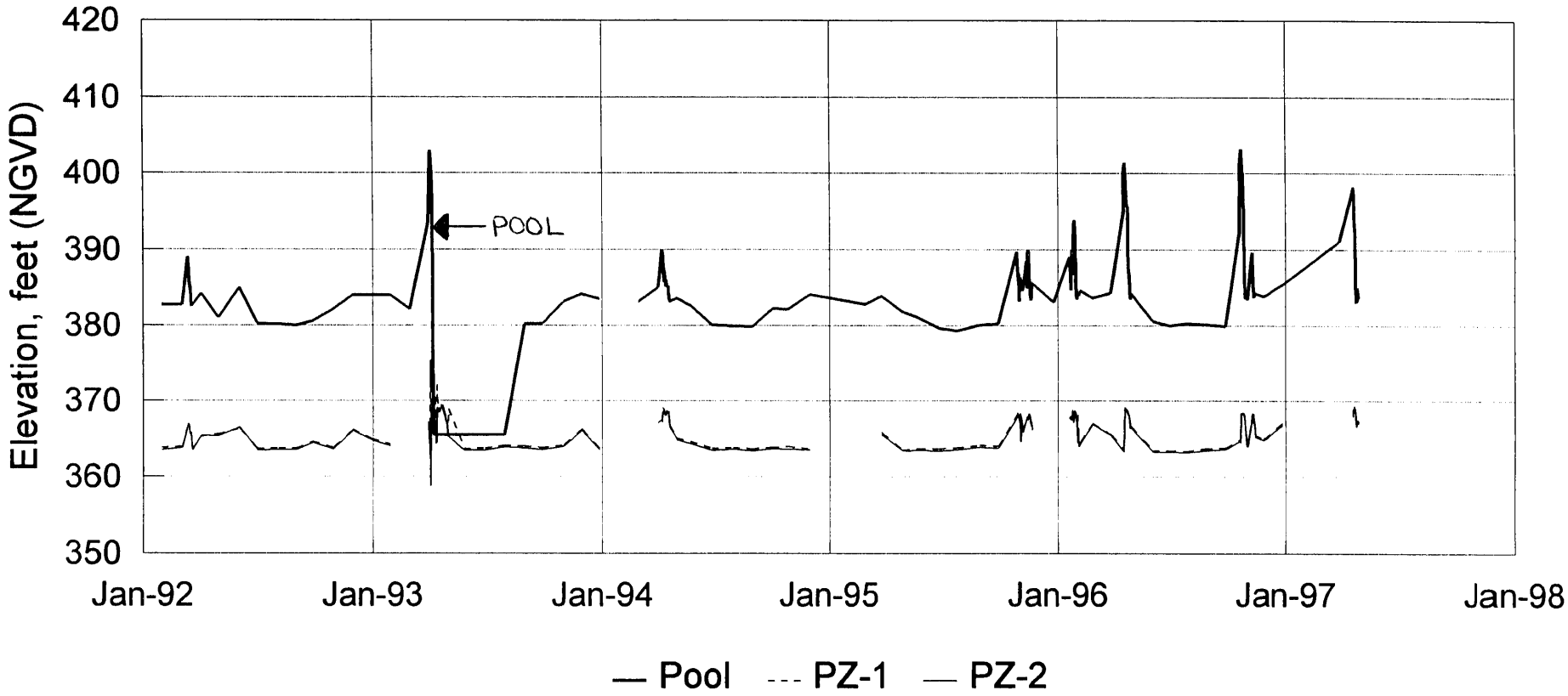
(2) Data Collection Tables. A table listing the piezometer identification number, stationing and offset, as well as piezometer top and tip elevations is also provided for recording and submitting piezometer readings. It should be noted that when two piezometers are located in the same protective casing, each shall be designated with a number as well as an "A" or "B". The letter "A" will indicate the deeper piezometer riser and the letter "B" shall designate the more shallow riser for each such location. All piezometers shall be clearly labeled with the appropriate identification number and letter (if required). These labels shall be installed inside of the protective casings and attached to each respective piezometer riser by the project manger.

(3) Destination. All data should be sent to the following address on the first of each month.

U.S. Army Corps of Engineers
New England Division
CENED-ED-GD
424 Trapello Road
Waltham, MA. 02254-9149
RE: PIEZOMETERS

(4) Special Conditions. If unusual changes in readings develop or if piezometers become inoperable, Geotechnical Engineering Branch should be contacted.

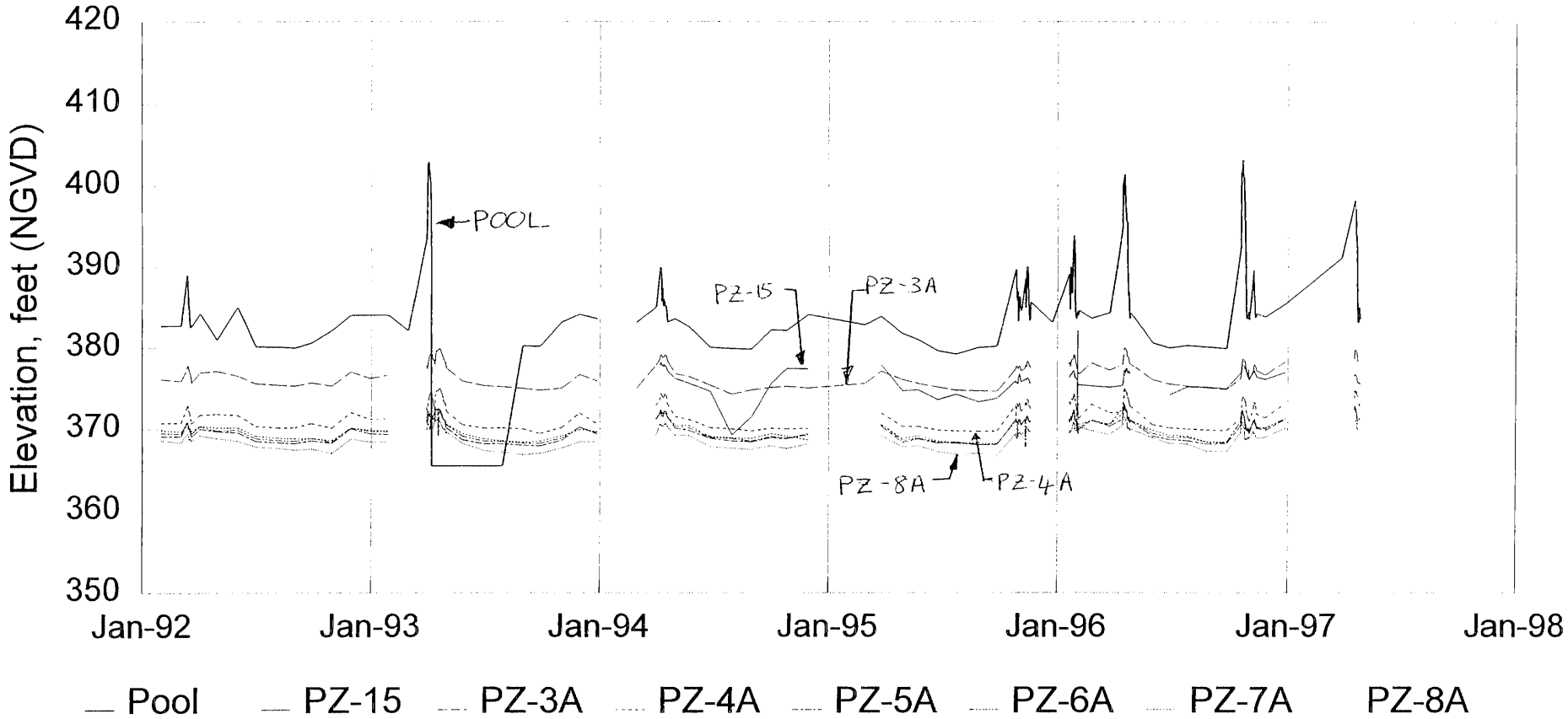
Piezometer Time History
Pool Elevation, PZ-1, and PZ-2



Note: Elevations at PZ-1 and PZ-2 were similar, therefore these lines plot on top of each other

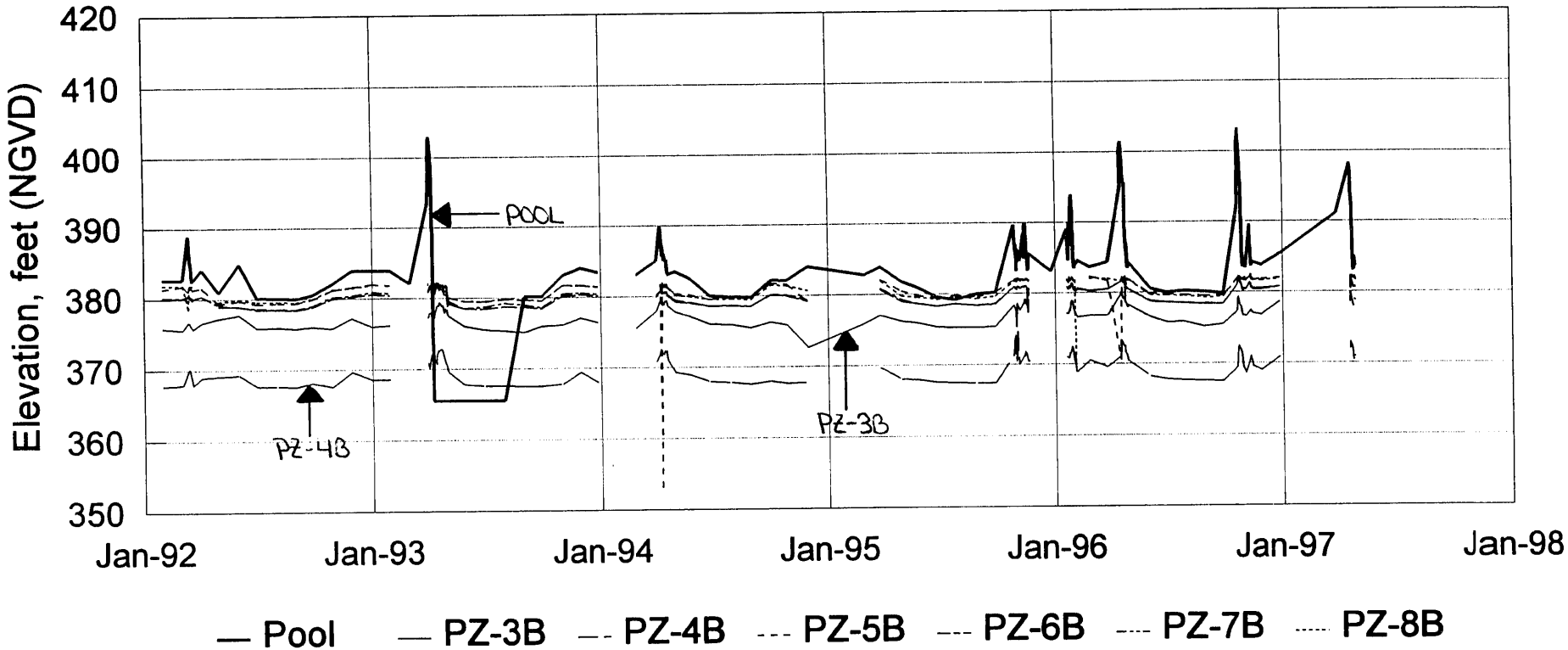
Piezometer Time History

Pool Elev, PZ-15, PZ-3A, PZ-4A, PZ-5A, PZ-6A, PZ-7A, and PZ-8A



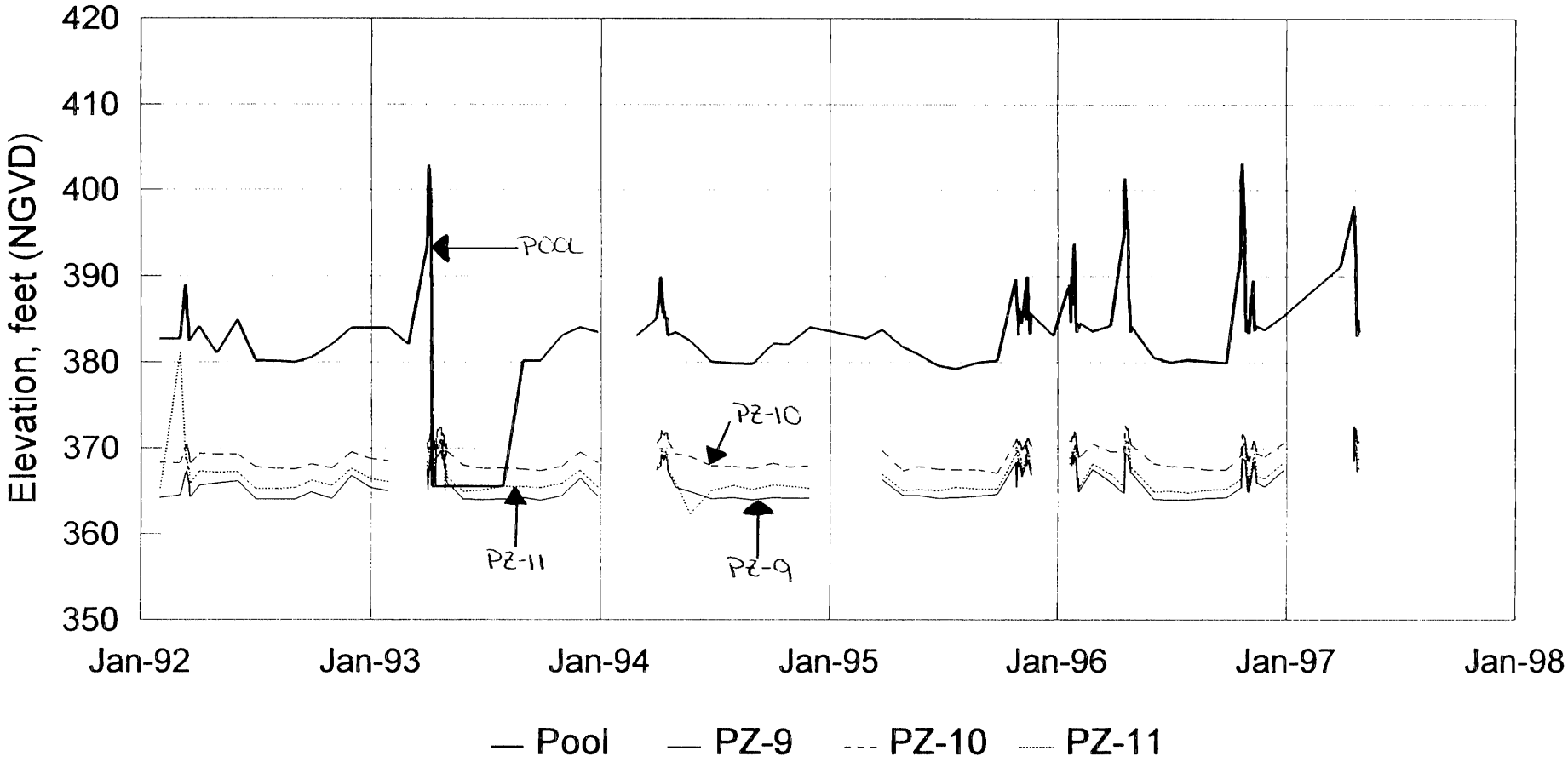
Note: Elevations at PZ-5A, PZ-6A, and PZ-7A were similar, therefore these lines plot on top of each other

Piezometer Time History
Pool Elev, PZ-3B, PZ-4B, PZ-5B, PZ-6B, PZ-7B, and PZ-8B

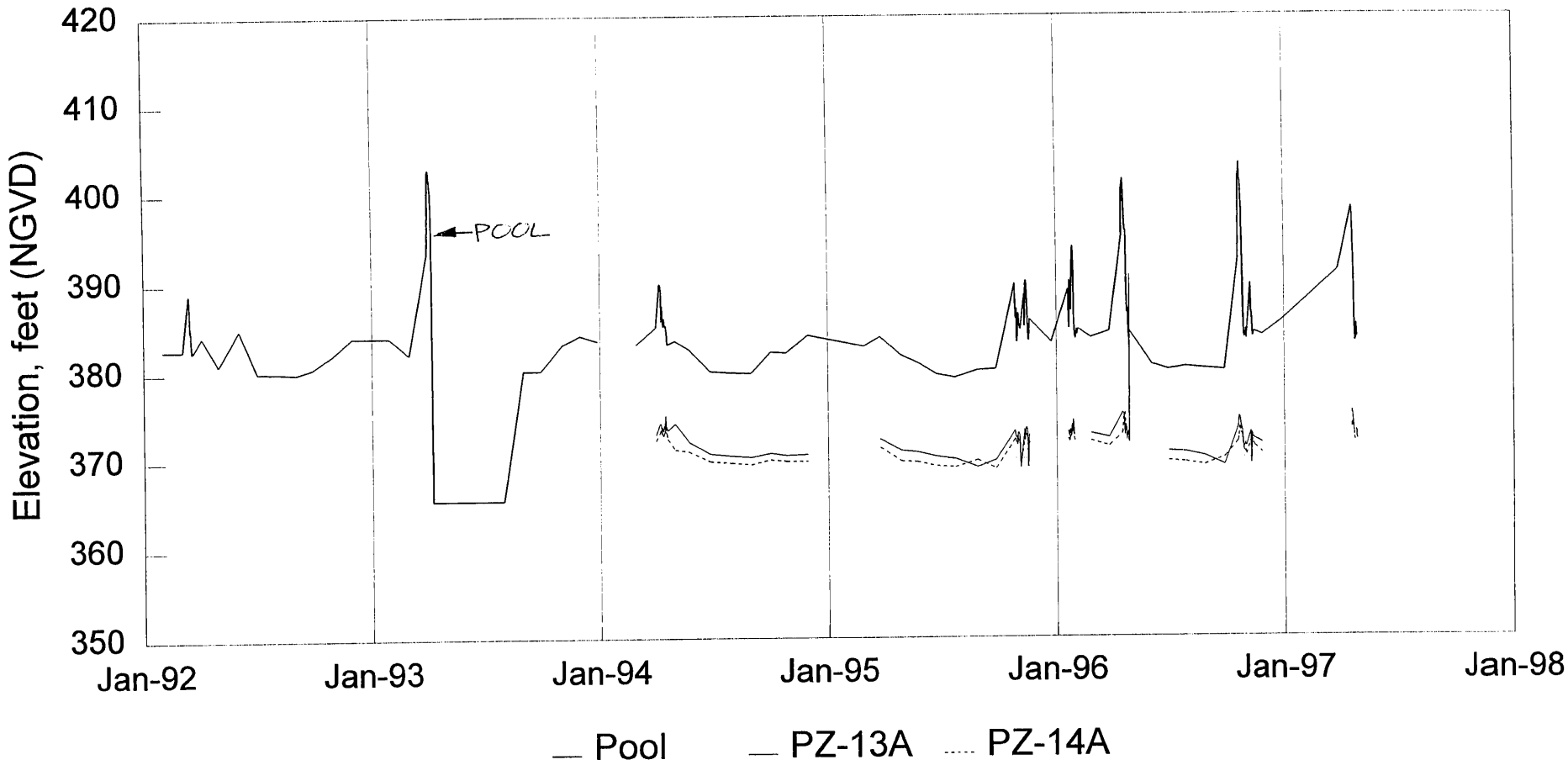


Note: Elevations at PZ-5B and PZ-8B were similar, therefore these lines plot on top of each other
Note: Elevations at PZ-6B and PZ-7B were similar, therefore these lines plot on top of each other

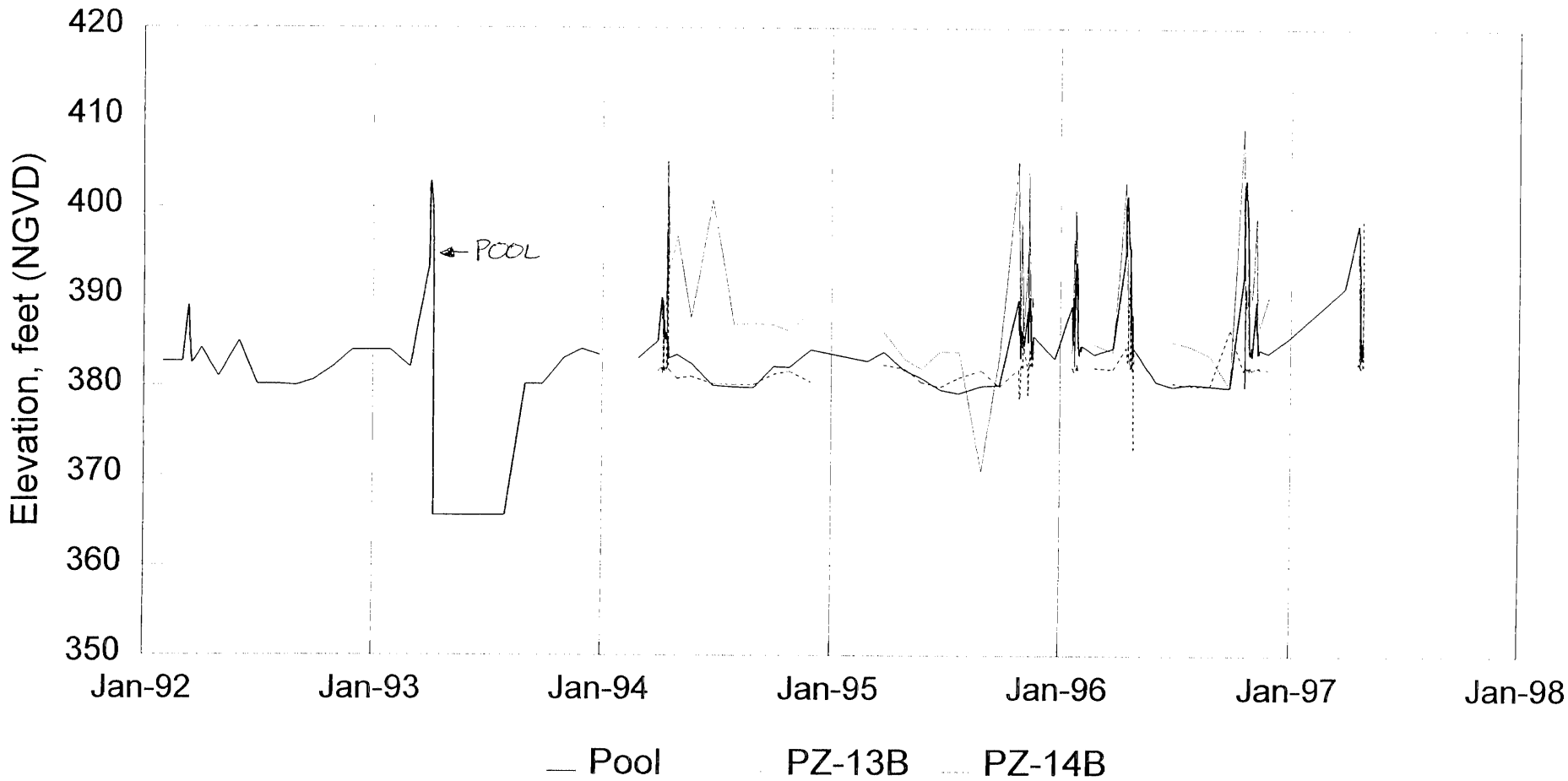
Piezometer Time History
Pool Elevation, PZ-9, PZ-10, and PZ-11



Piezometer Time History
Pool Elevation, PZ-13A, and PZ-14A

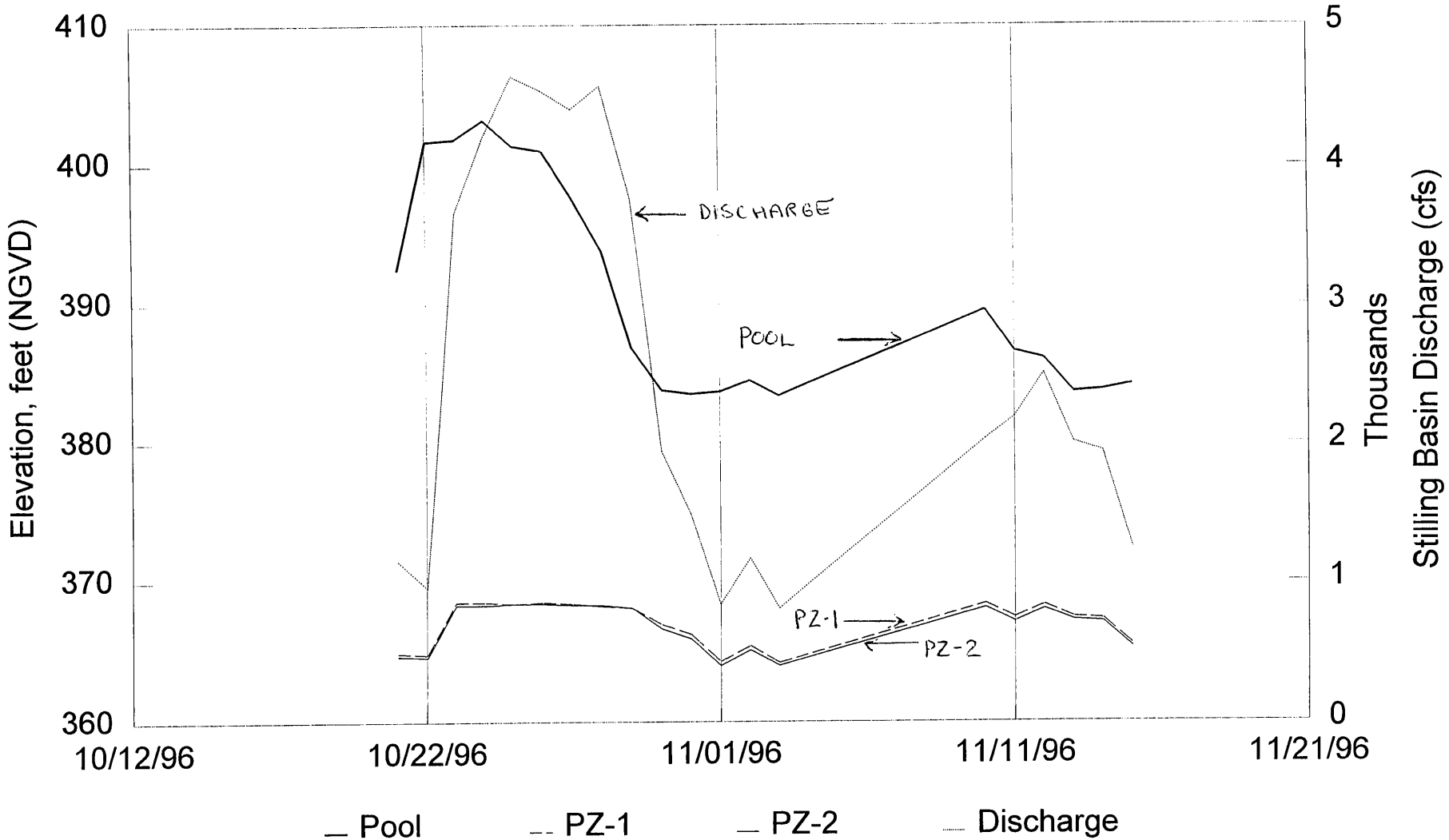


Piezometer Time History
Pool Elevation, PZ-13B, and PZ-14B



October 1996 High Pool Event

Pool Elevation, PZ-1, PZ-2 and Stilling Basin Discharge



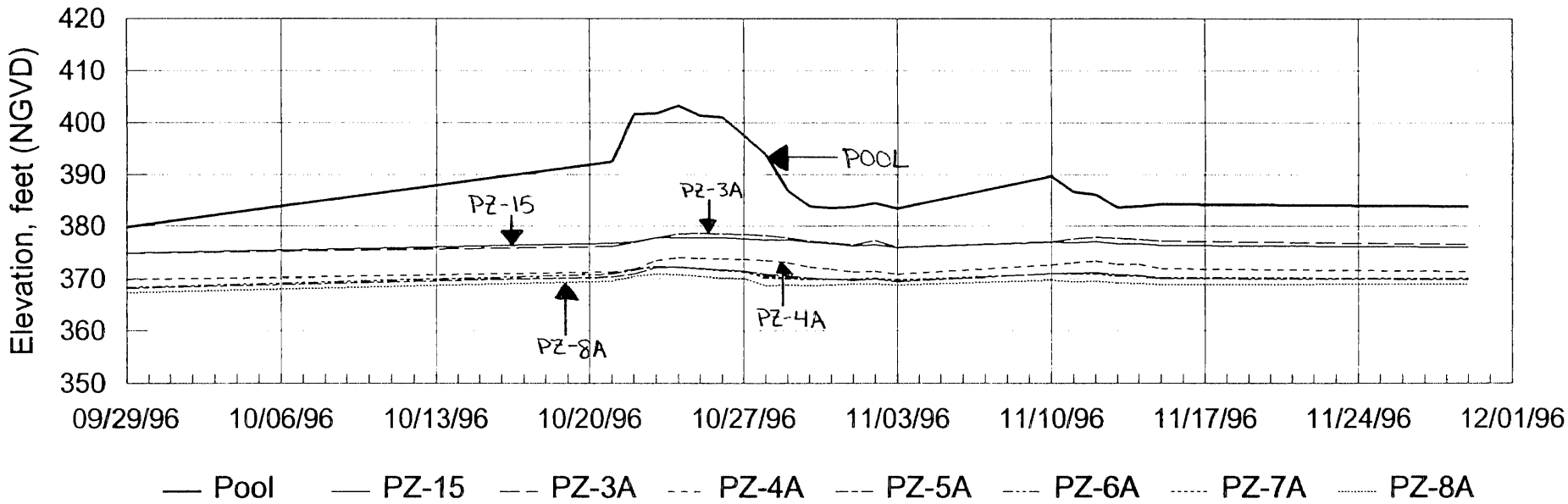
GEI Consultants, Inc.

Hopkinton Dam

Project 97487

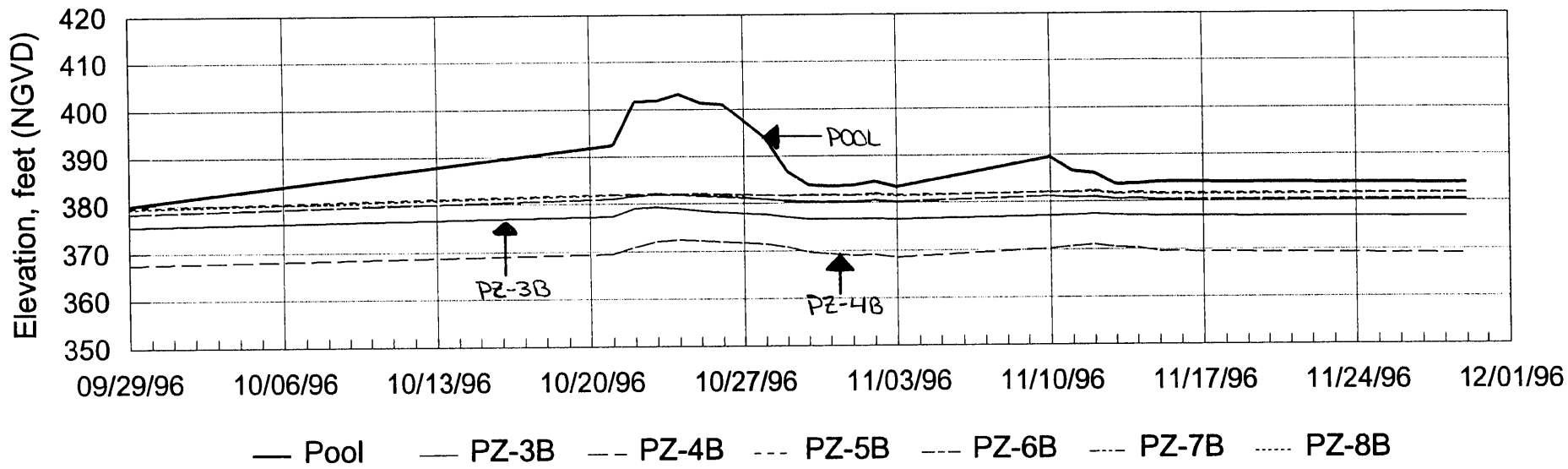
PLATE D.1

October 1996 High Pool Event
Pool Elev, PZ-15, PZ-3A, PZ-4A, PZ-5A, PZ-6A, PZ-7A, and PZ-8A



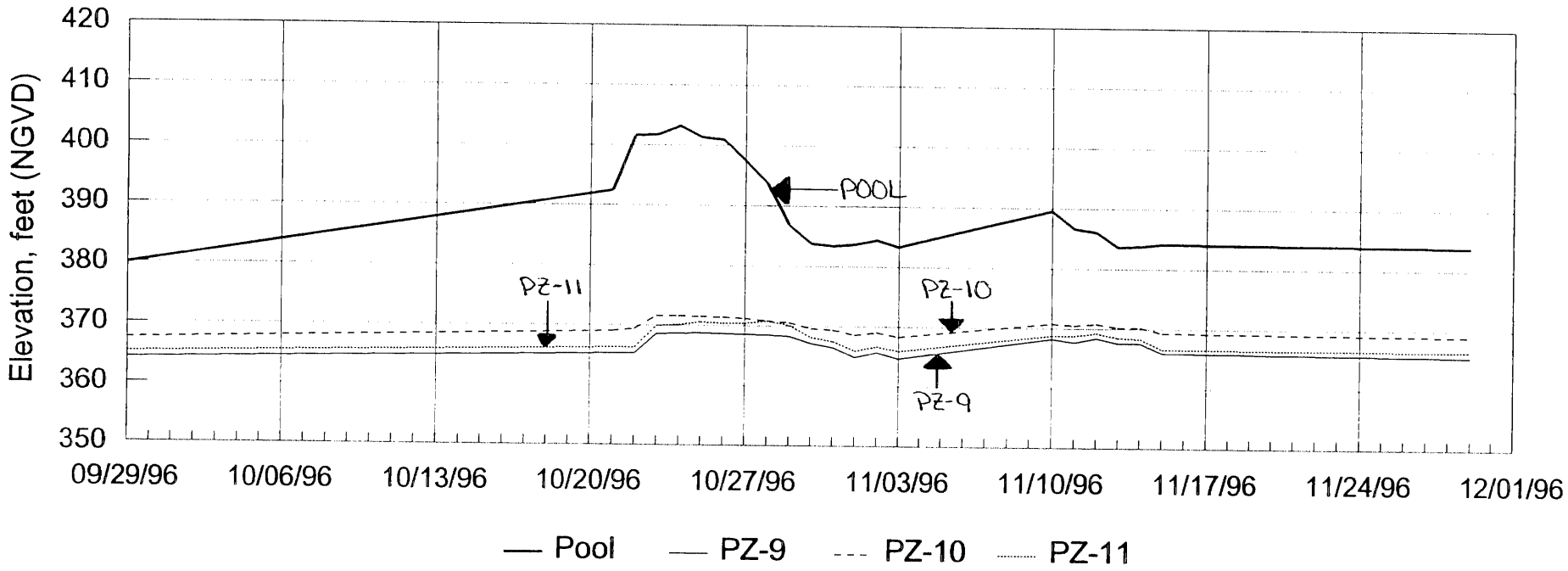
Note: Elevations at PZ-5A, PZ-6A, and PZ-7A were similar, therefore these lines plot on top of each other

October 1996 High Pool Event
Pool Elev, PZ-3B, PZ-4B, PZ-5B, PZ-6B, PZ-7B, and PZ-8B

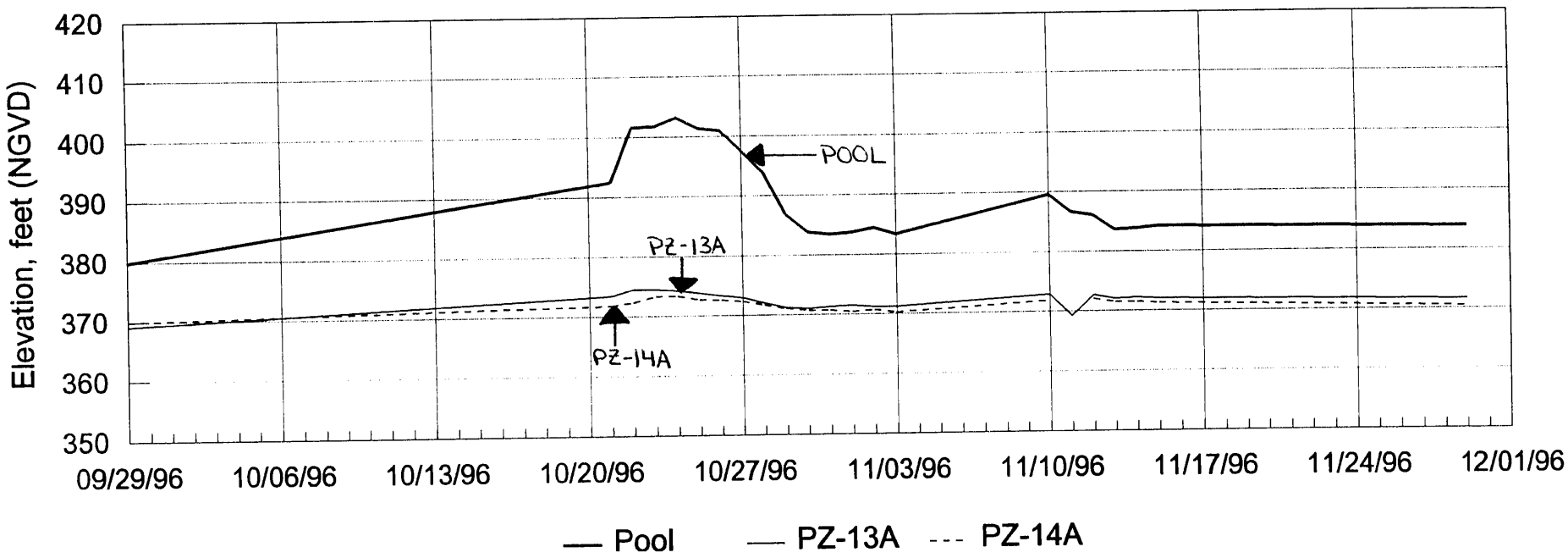


Note: Elevations at PZ-5B and PZ-8B were similar, therefore these lines plot on top of each other
Note: Elevations at PZ-6B and PZ-7B were similar, therefore these lines plot on top of each other

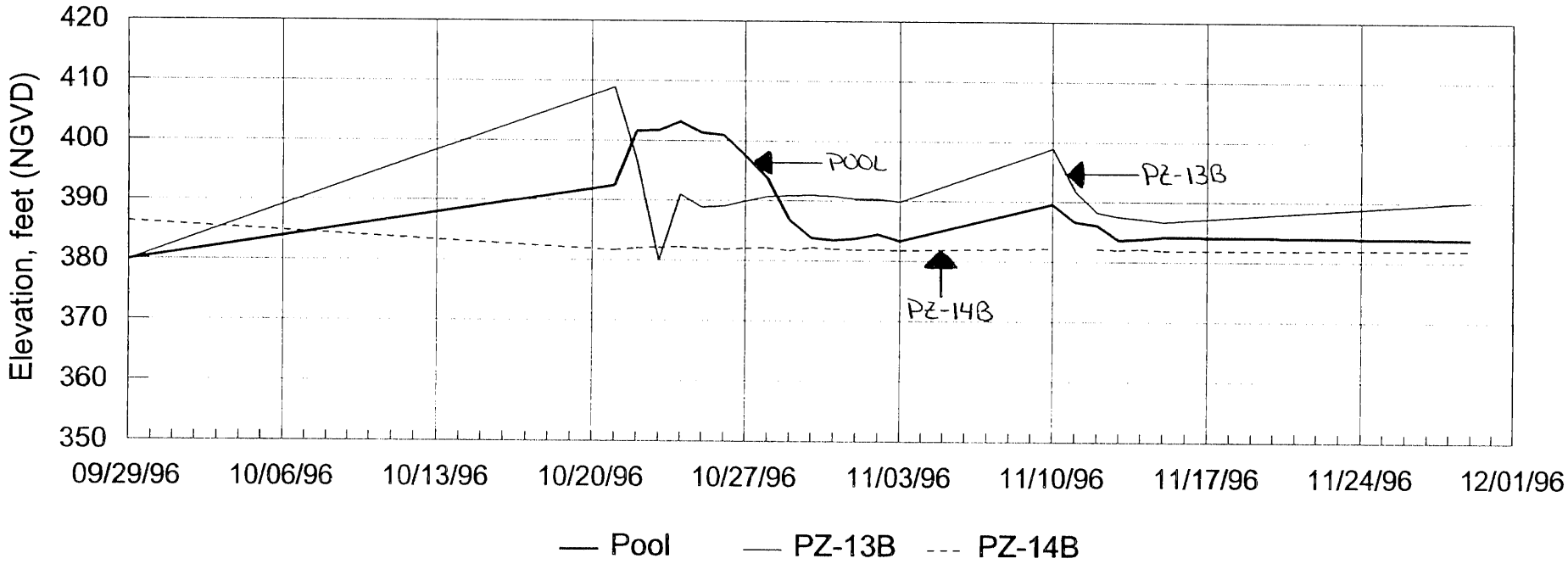
October 1996 High Pool Event
Pool Elevation, PZ-9, PZ-10, and PZ-11



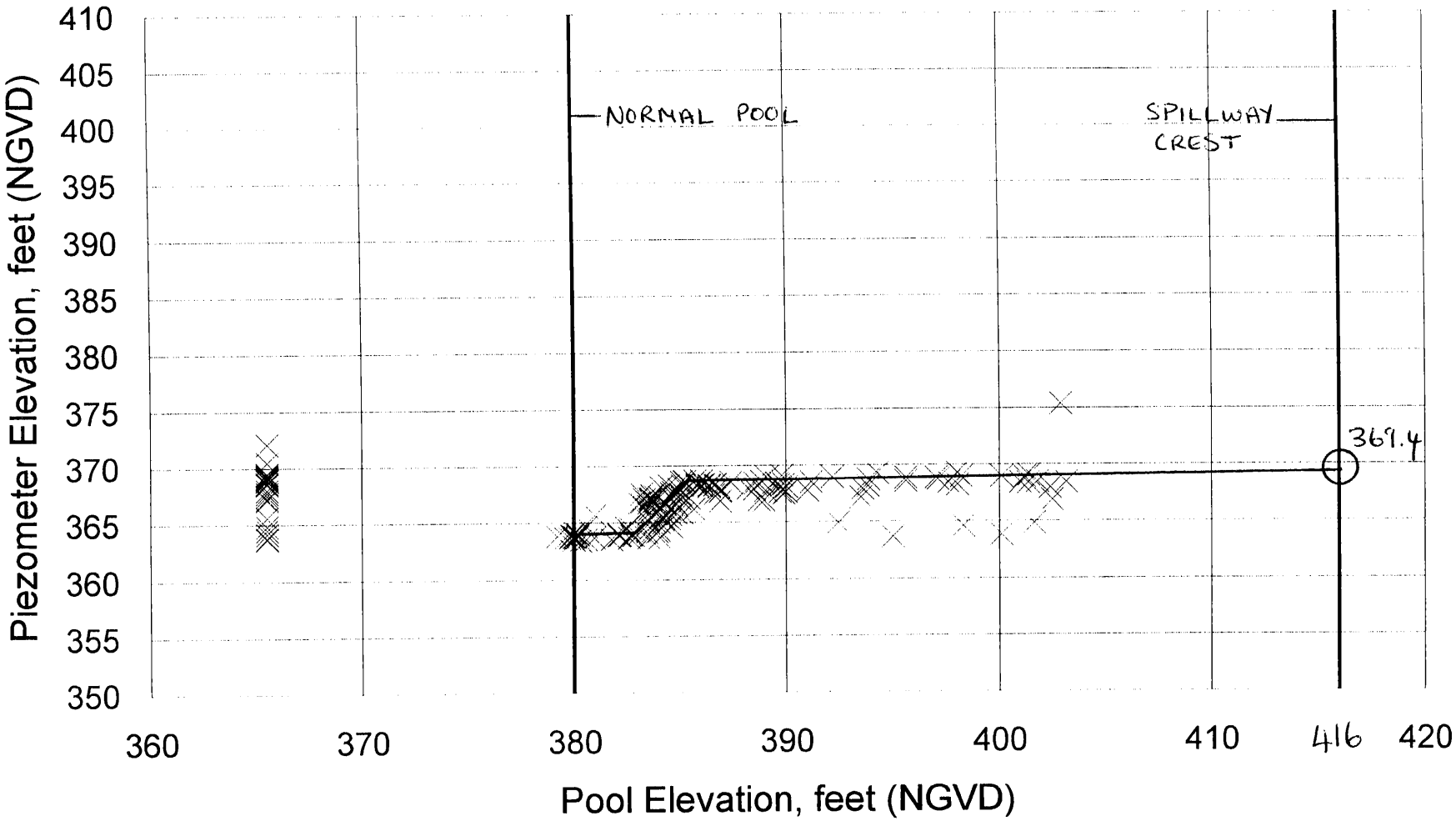
October 1996 High Pool Event
Pool Elevation, PZ-13A, and PZ-14A



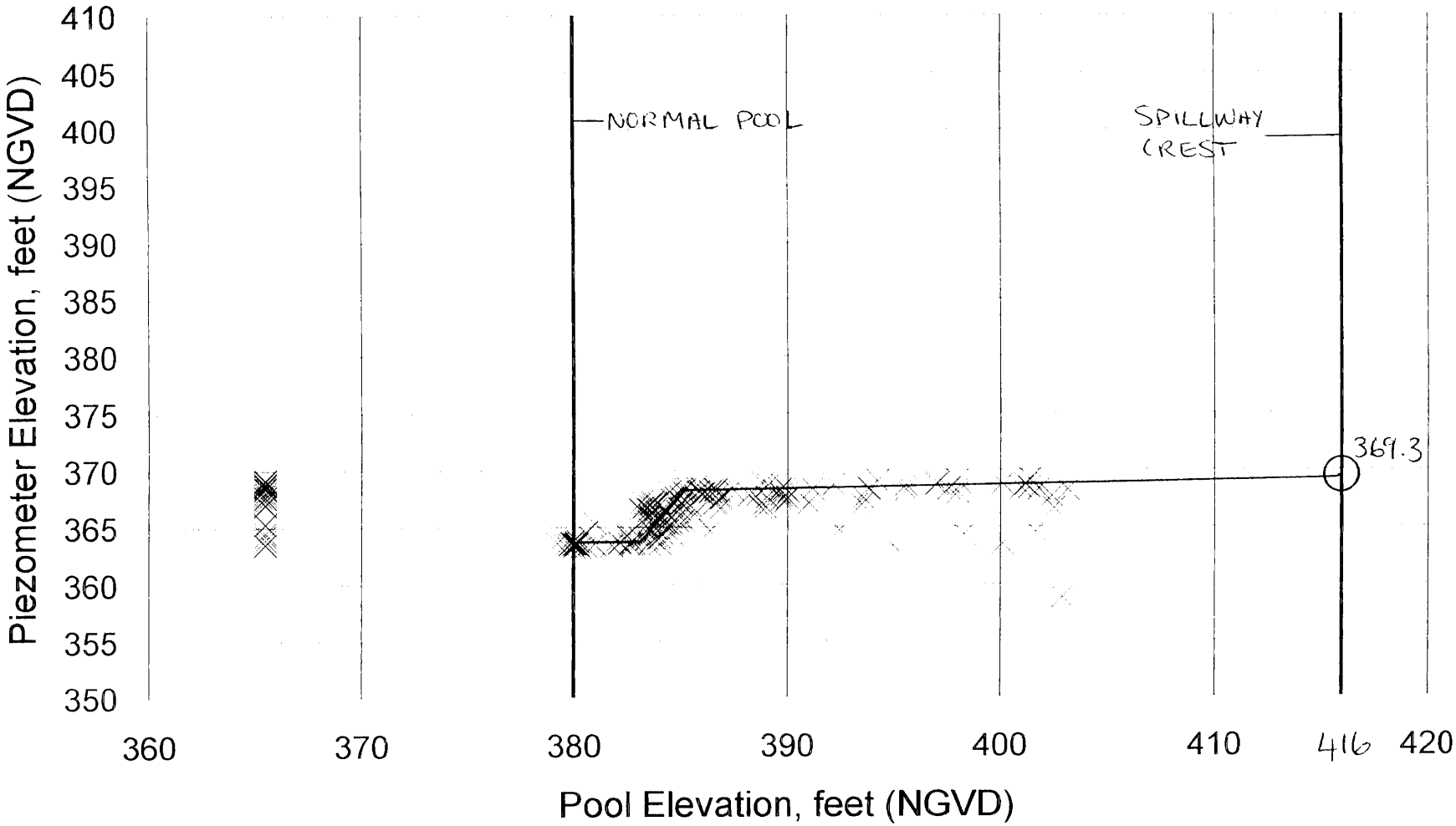
October 1996 High Pool Event
Pool Elevation, PZ-13B, and PZ-14B



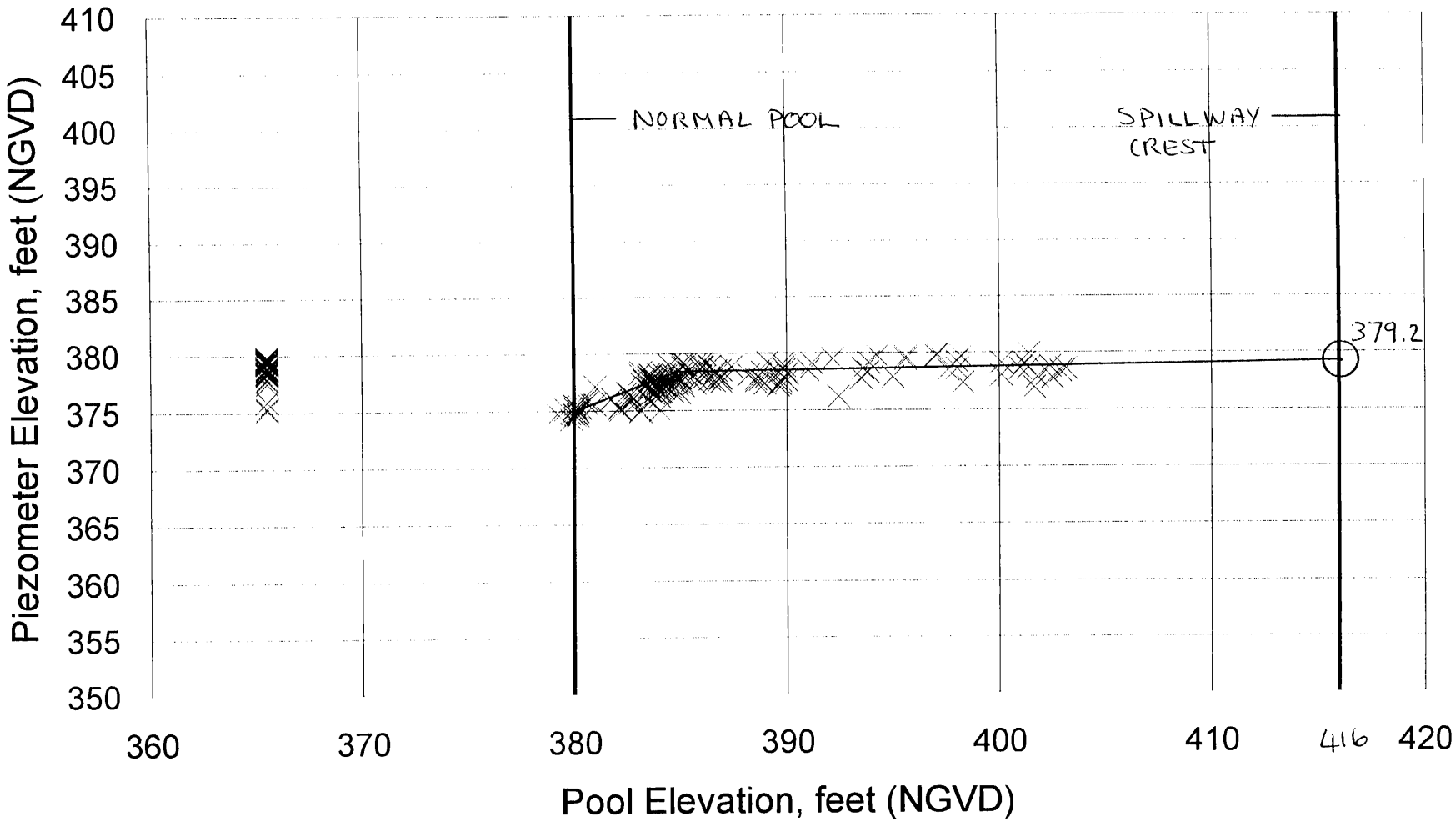
Piezometer Elevation vs. Pool Elevation
PZ-1



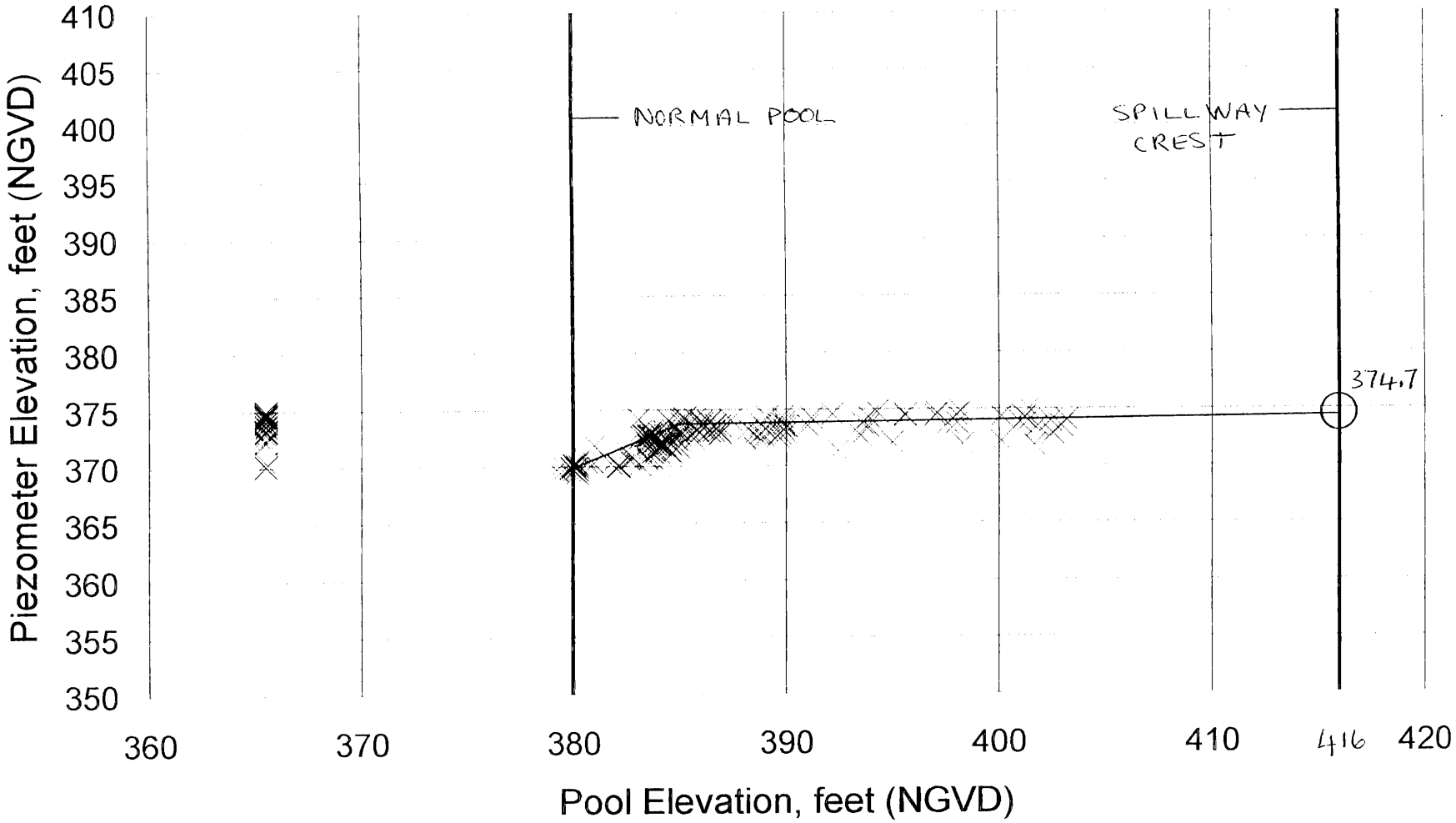
Piezometer Elevation vs. Pool Elevation
PZ-2



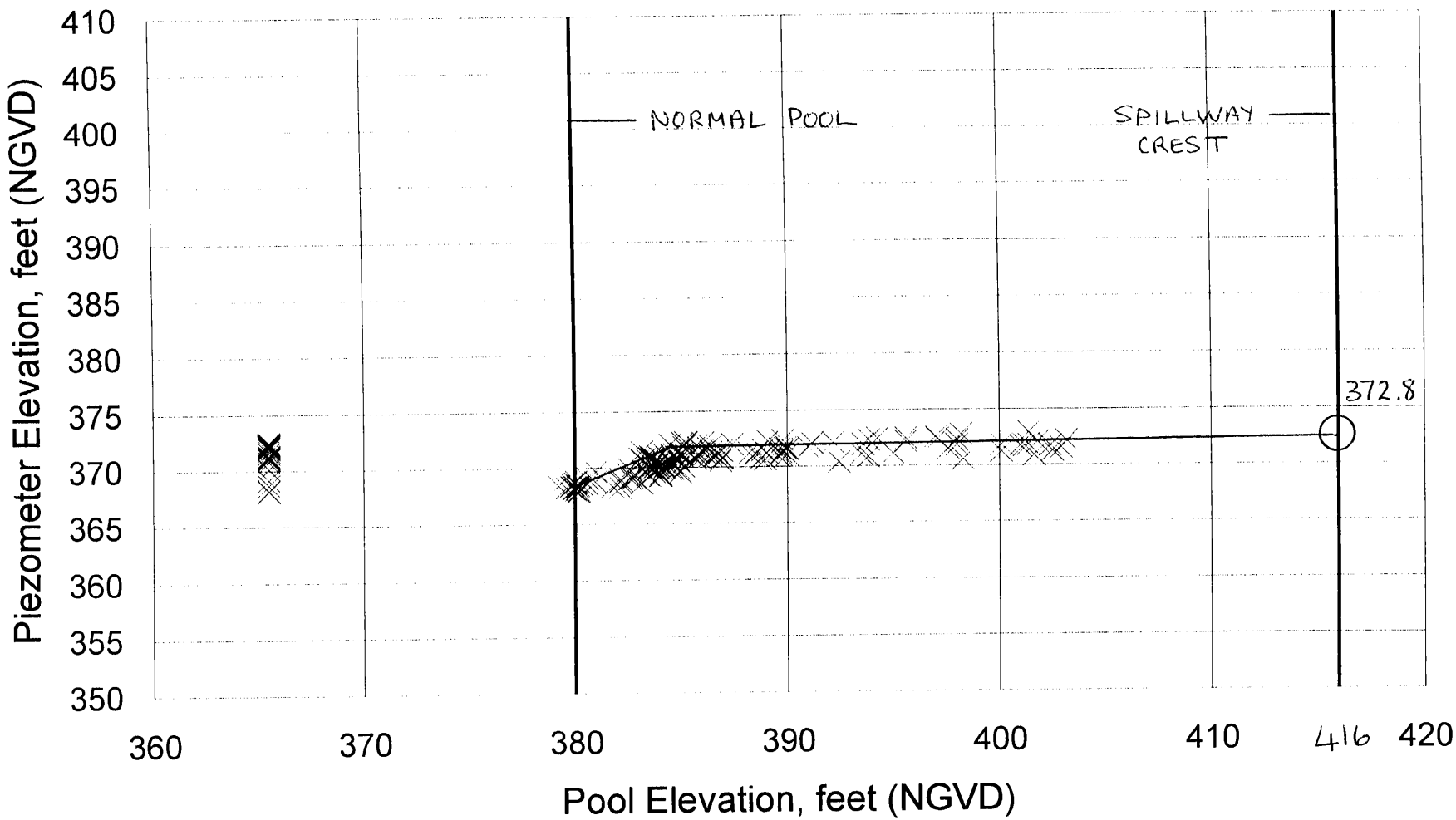
Piezometer Elevation vs. Pool Elevation
PZ-3A



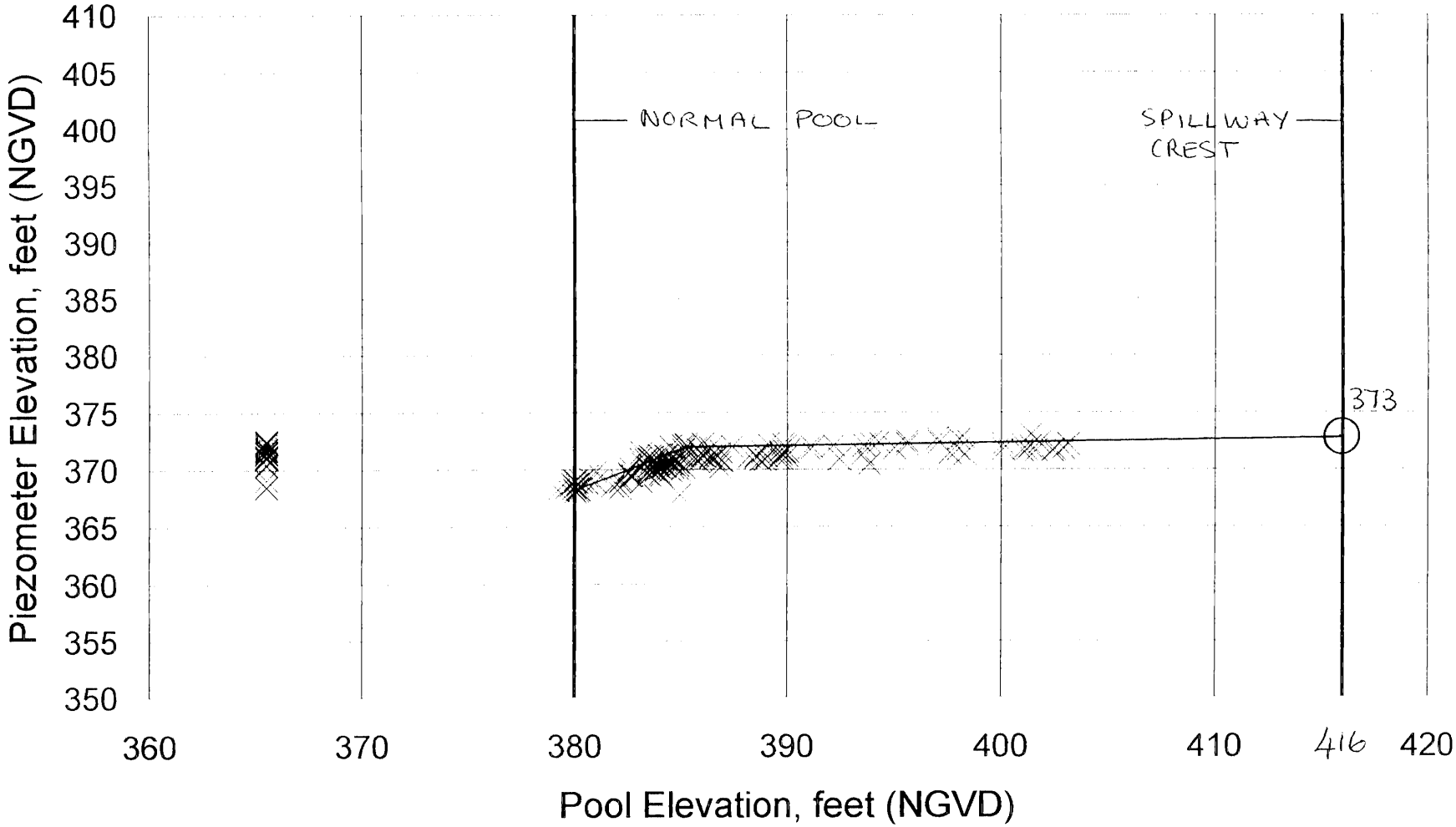
Piezometer Elevation vs. Pool Elevation
PZ-4A



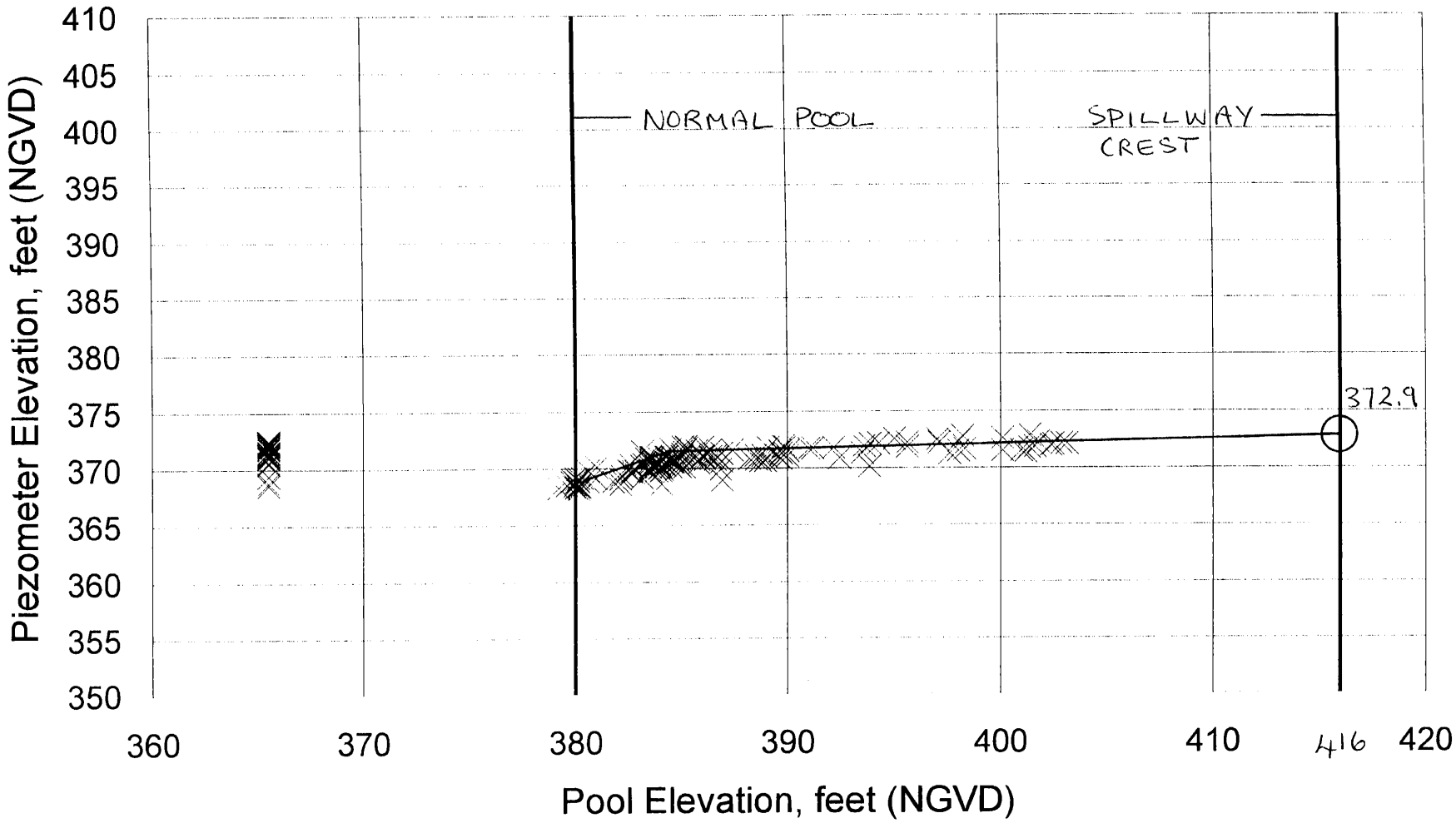
Piezometer Elevation vs. Pool Elevation
PZ-5A



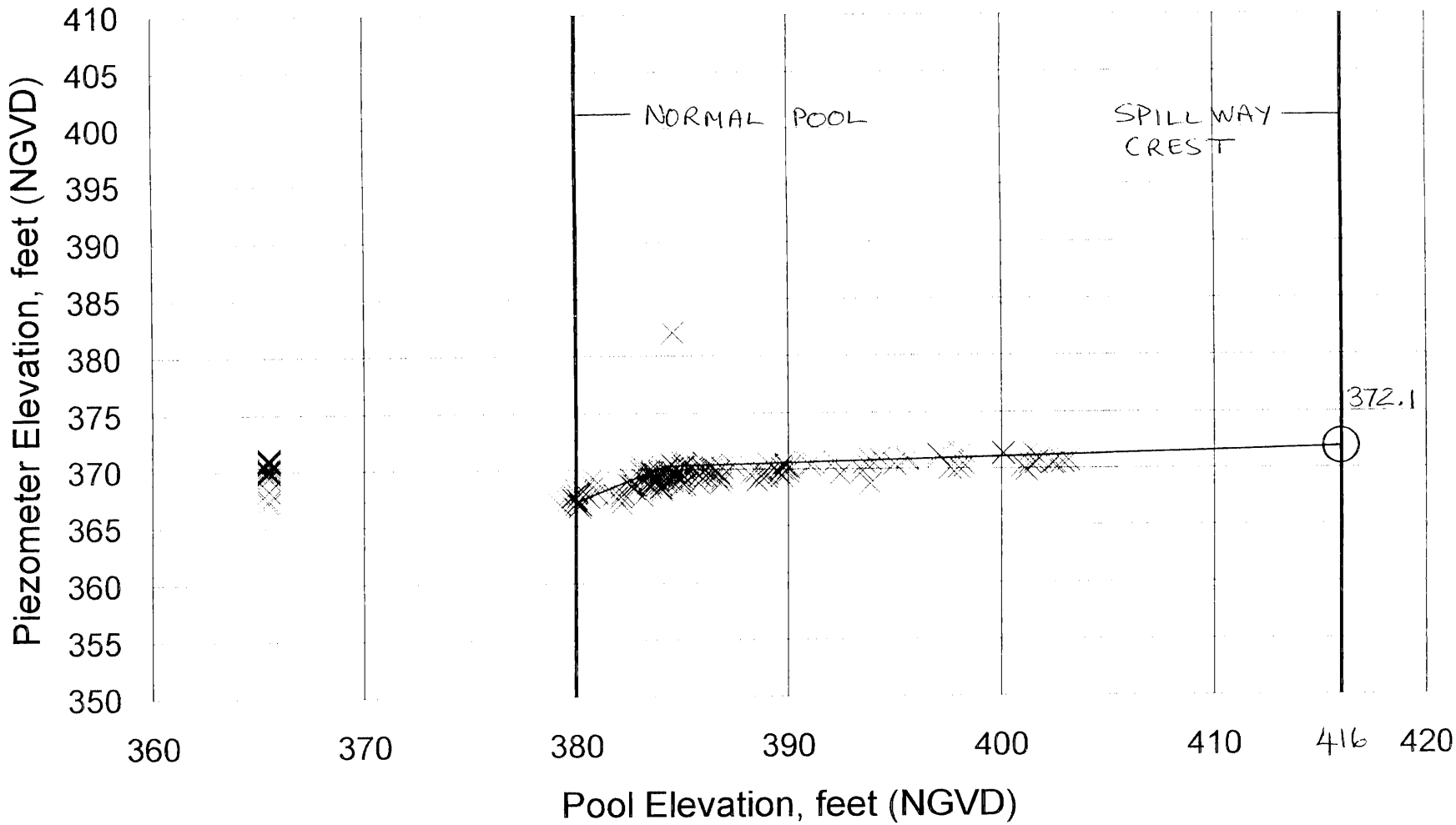
Piezometer Elevation vs. Pool Elevation
PZ-6A



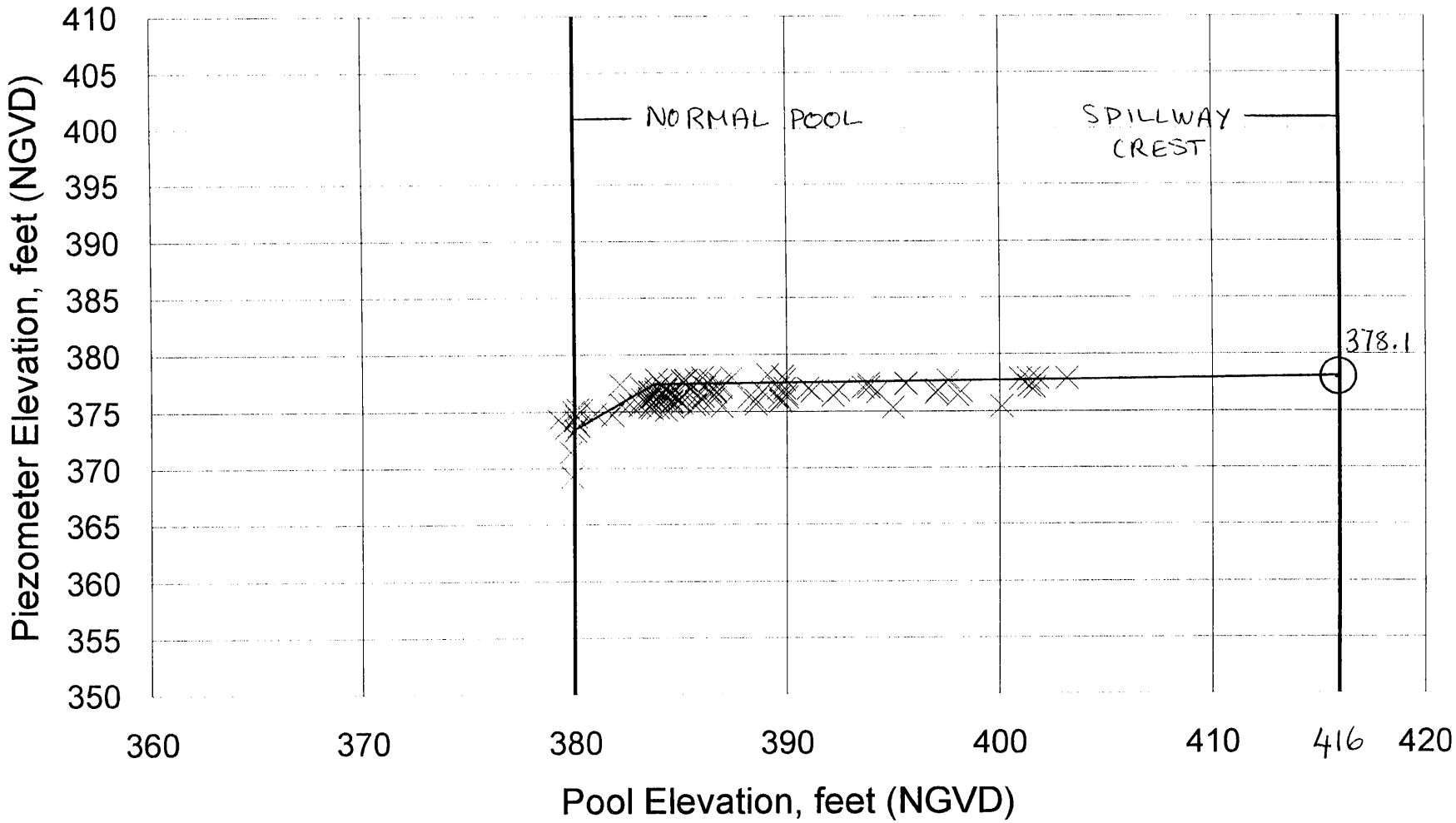
Piezometer Elevation vs. Pool Elevation
PZ-7A



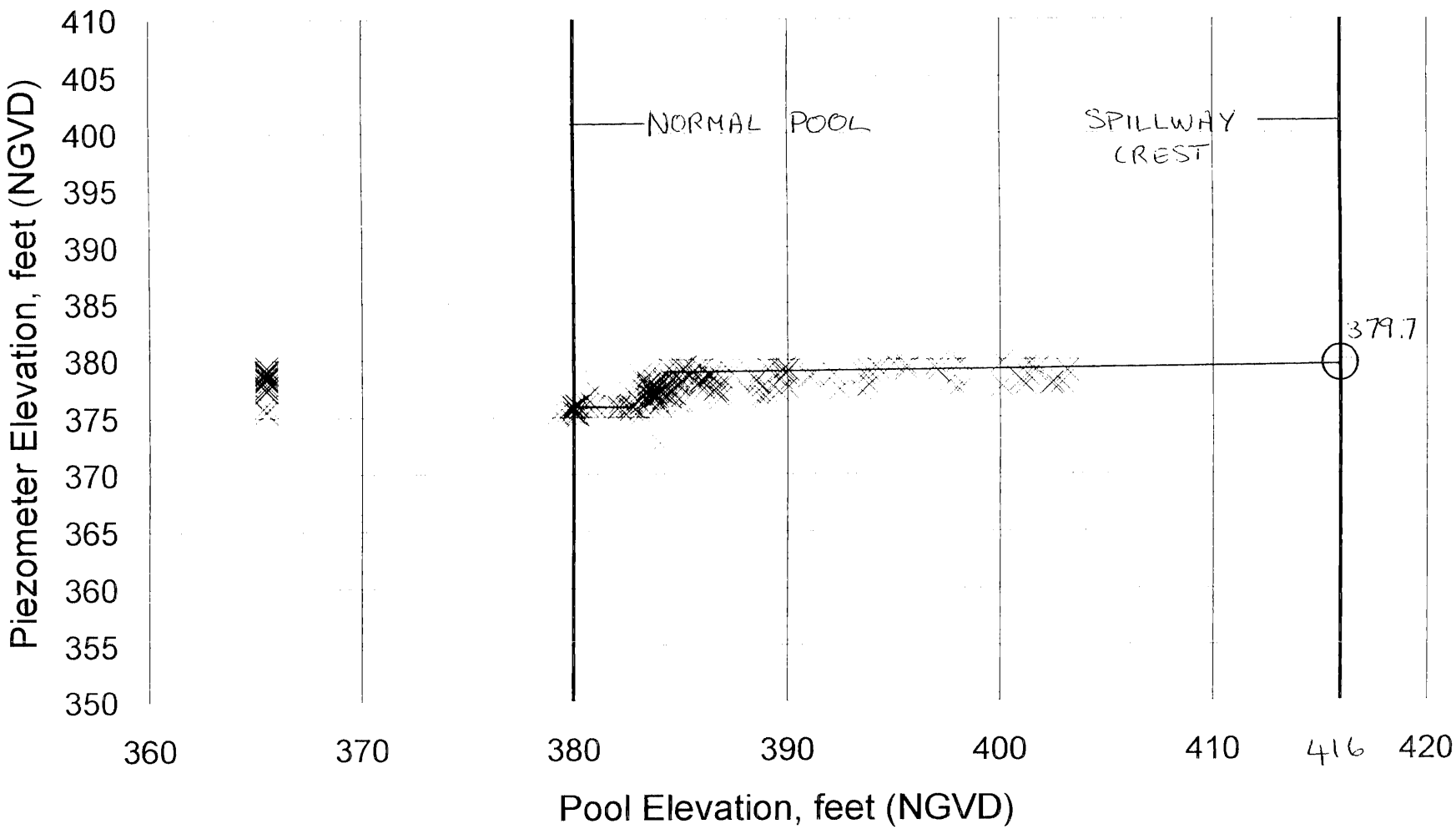
Piezometer Elevation vs. Pool Elevation
PZ-8A



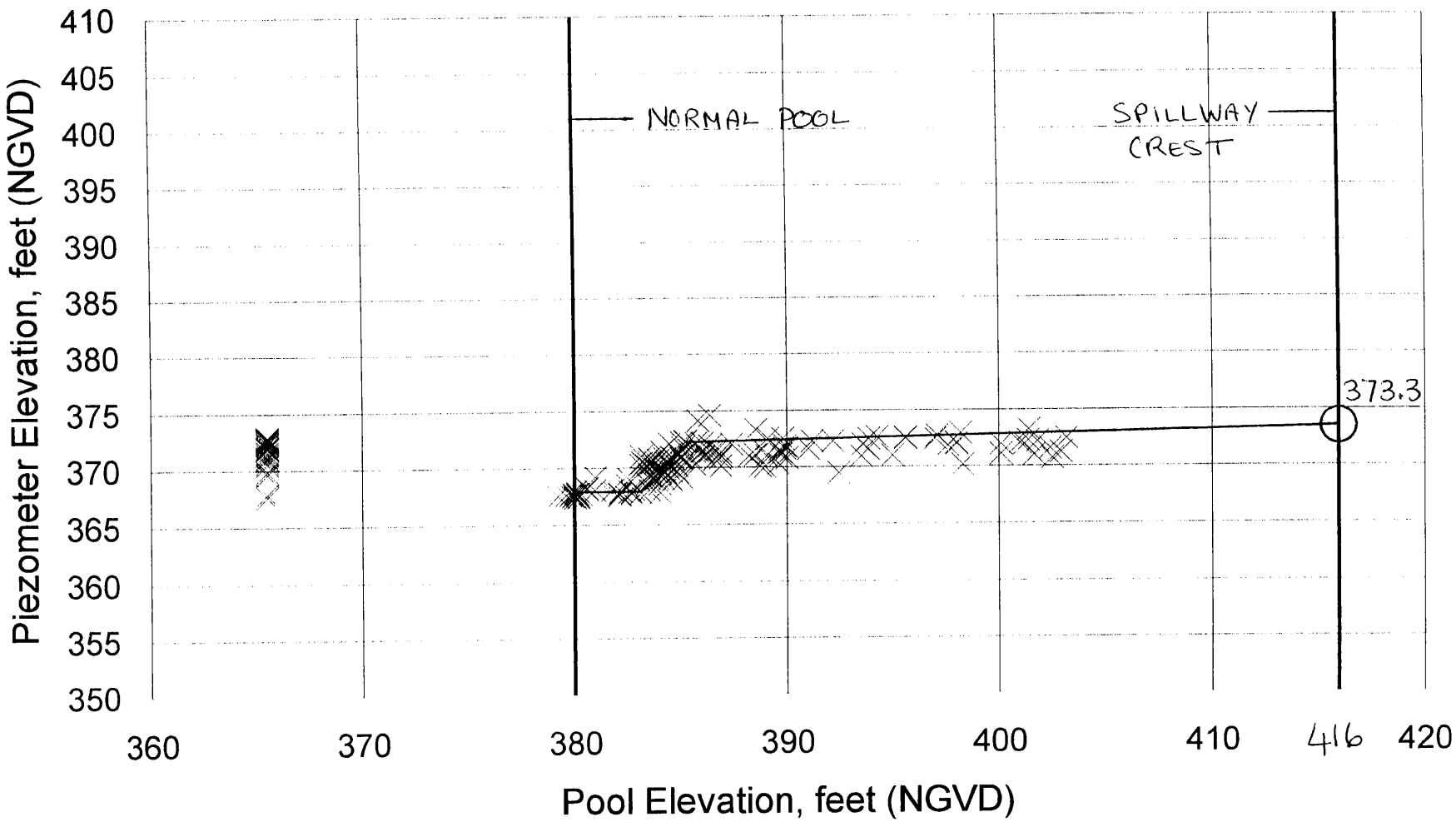
Piezometer Elevation vs. Pool Elevation
PZ-15



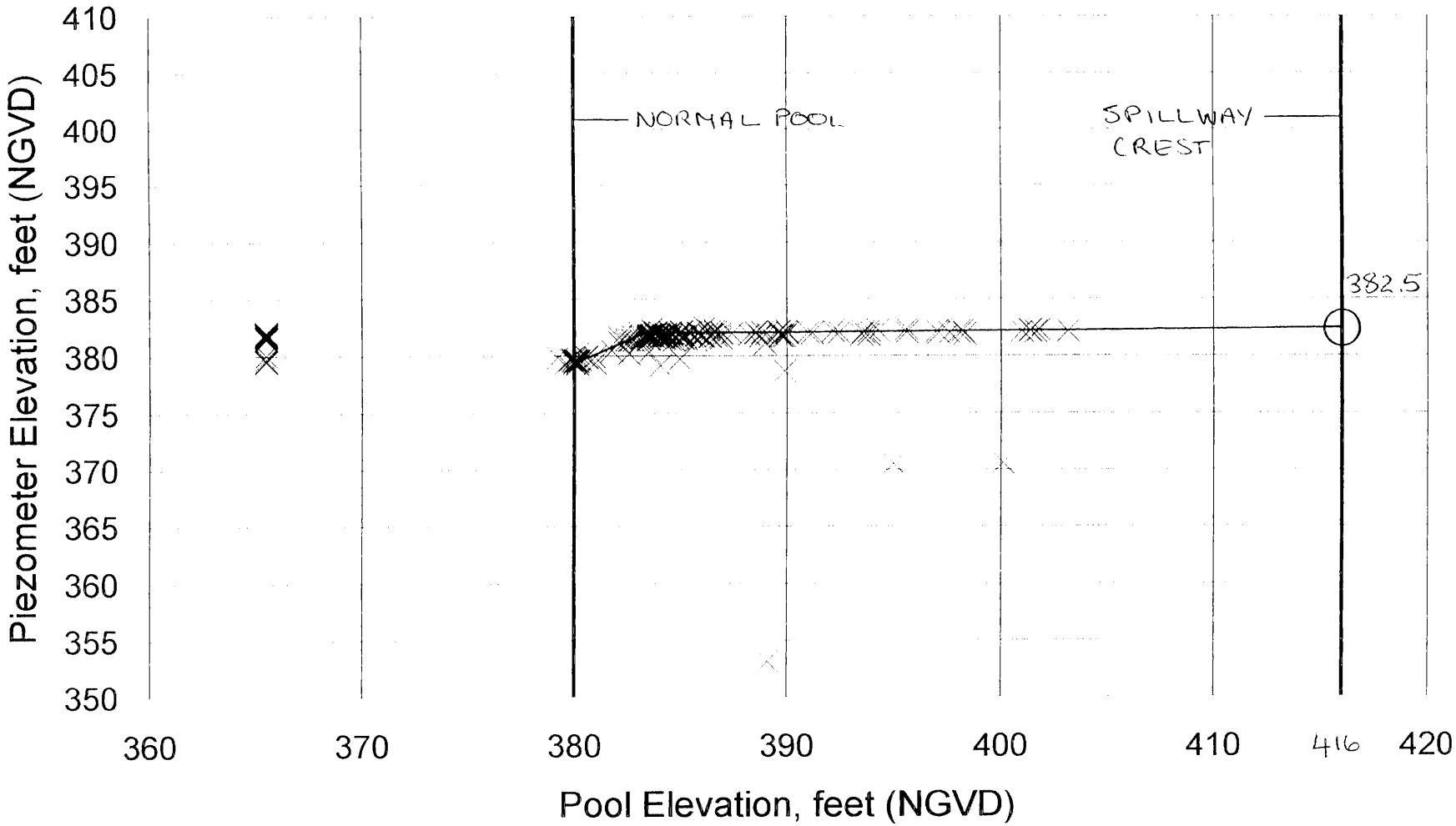
Piezometer Elevation vs. Pool Elevation
PZ-3B



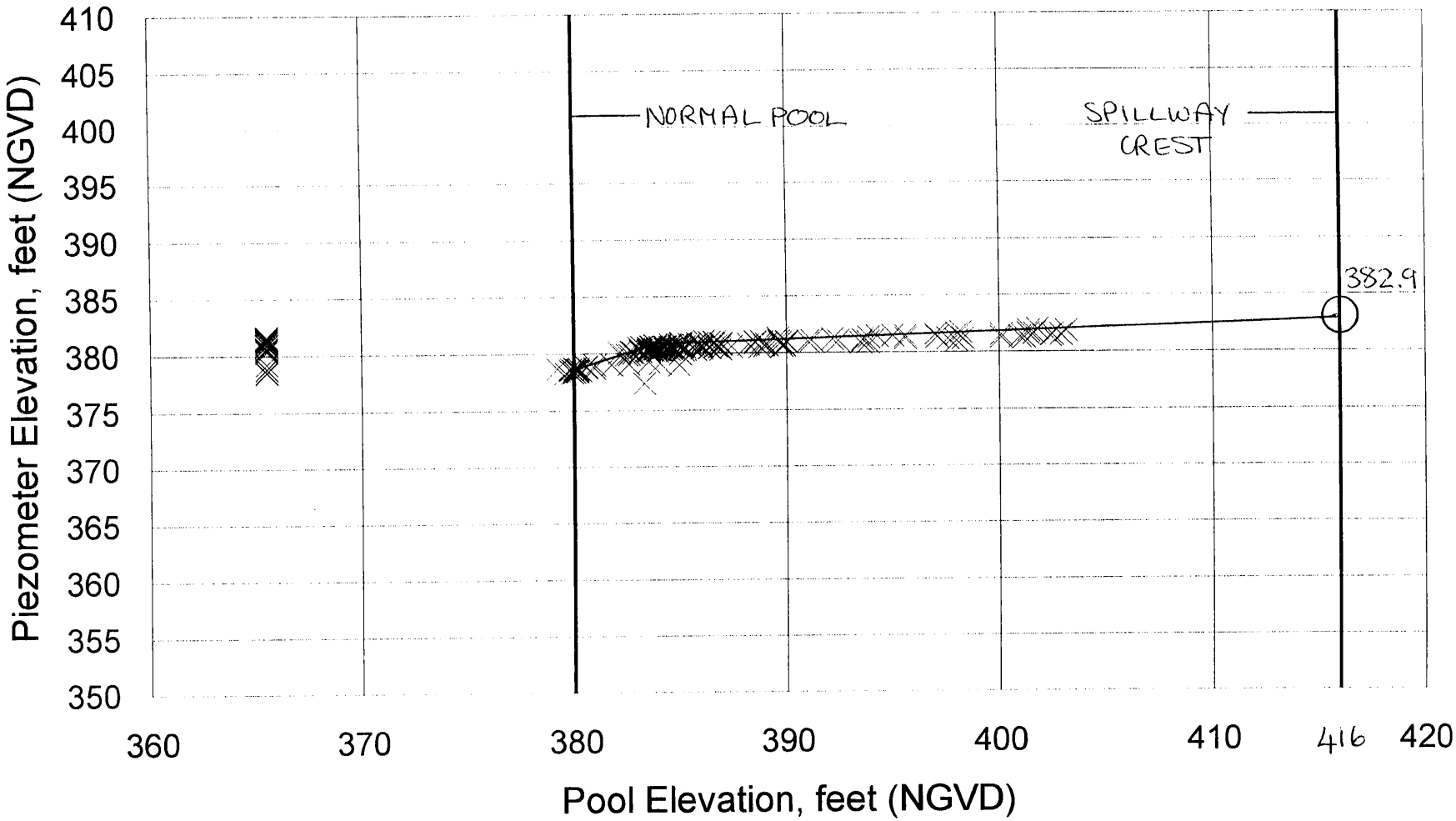
Piezometer Elevation vs. Pool Elevation
PZ-4B



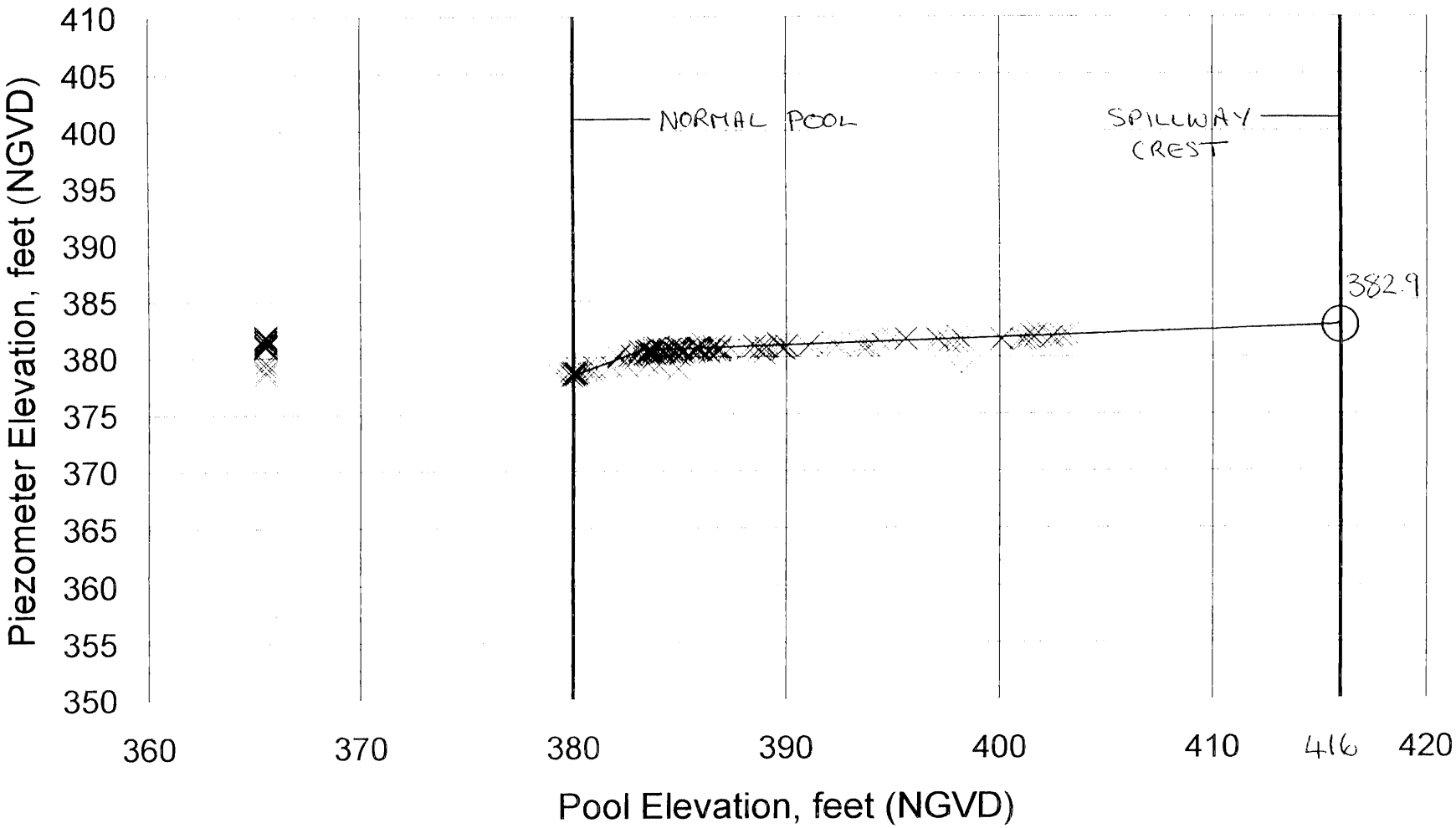
Piezometer Elevation vs. Pool Elevation
PZ-5B



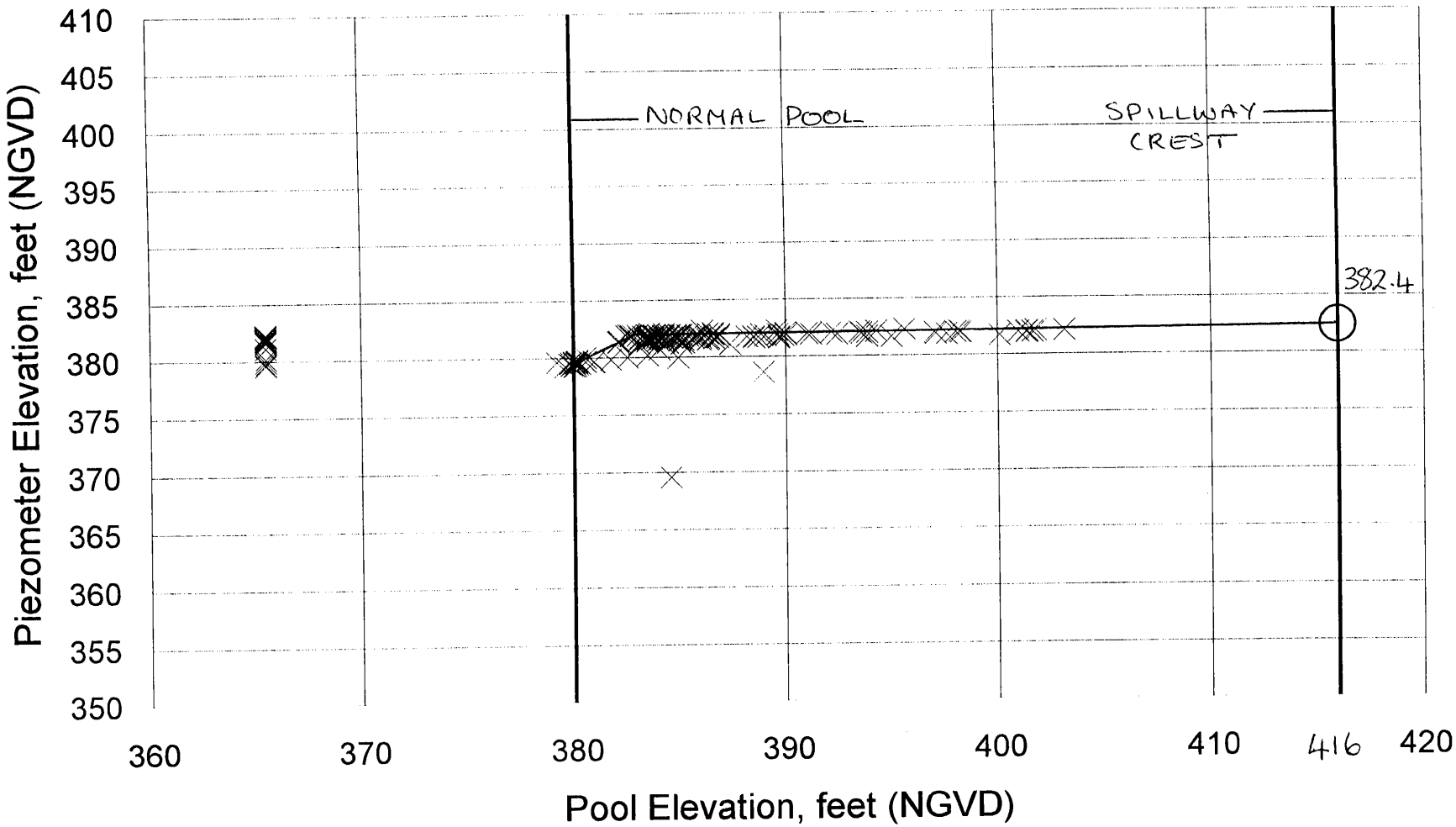
Piezometer Elevation vs. Pool Elevation
PZ-6B



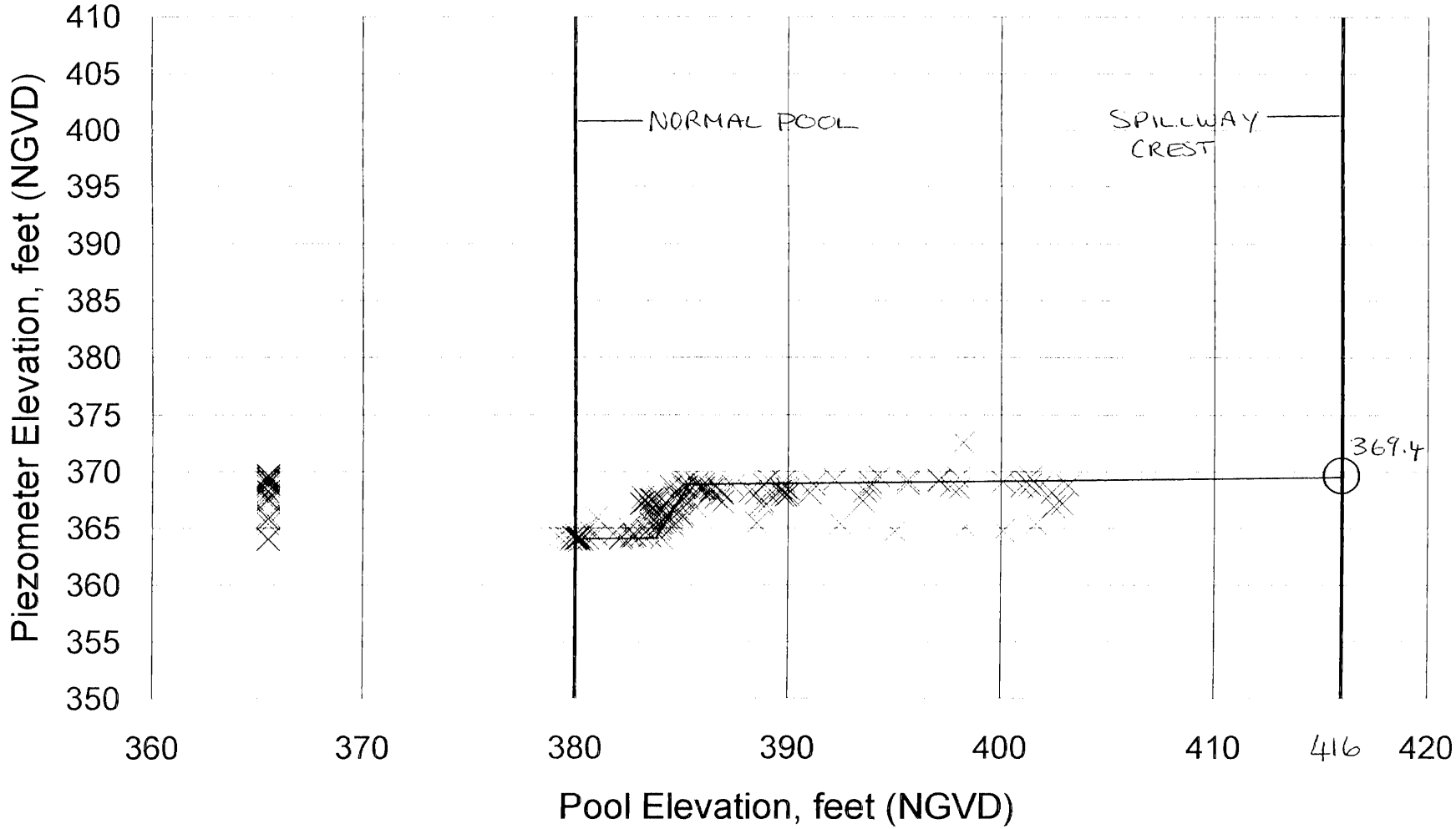
Piezometer Elevation vs. Pool Elevation
PZ-7B



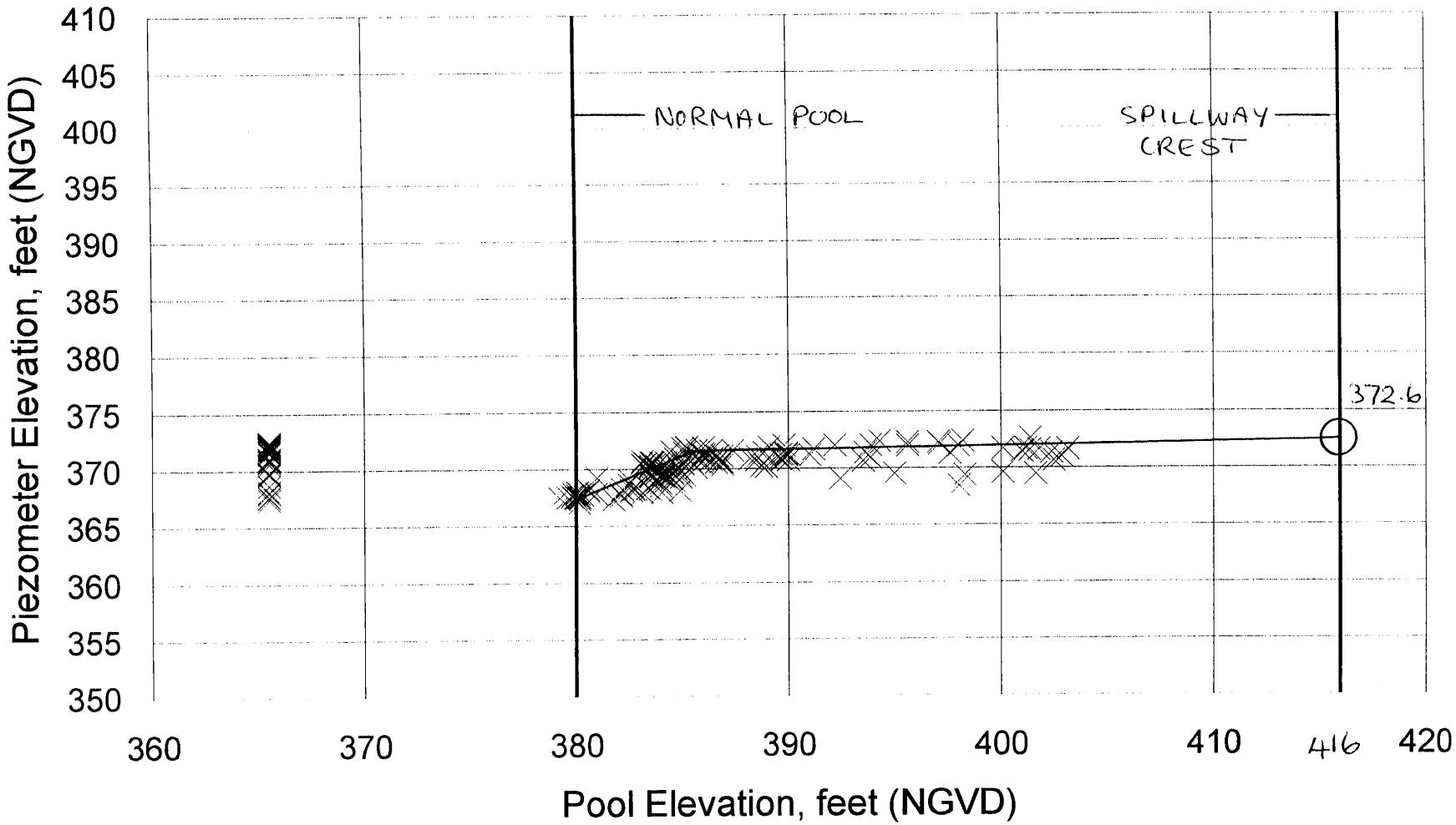
Piezometer Elevation vs. Pool Elevation
PZ-8B



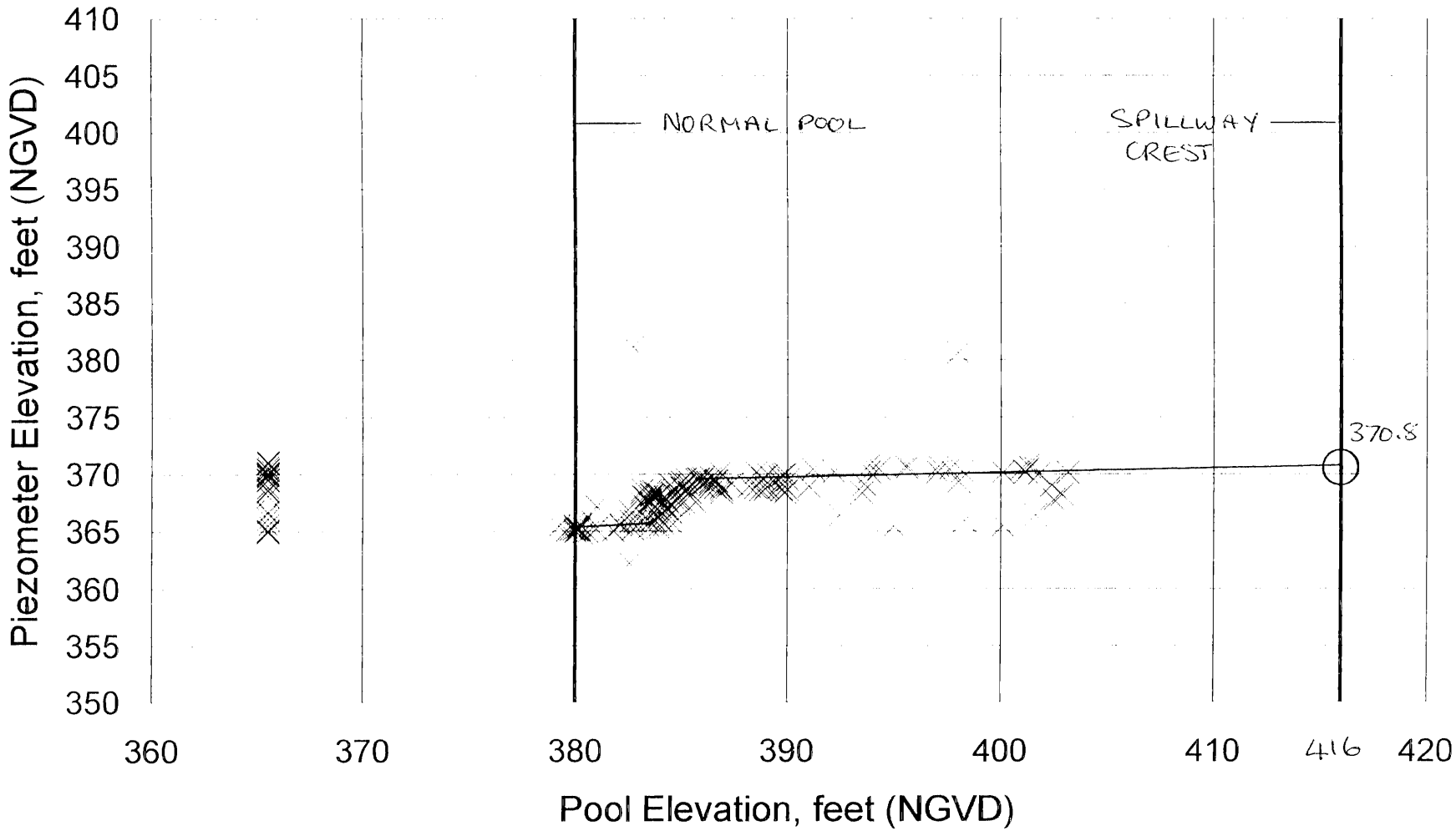
Piezometer Elevation vs. Pool Elevation
PZ-9



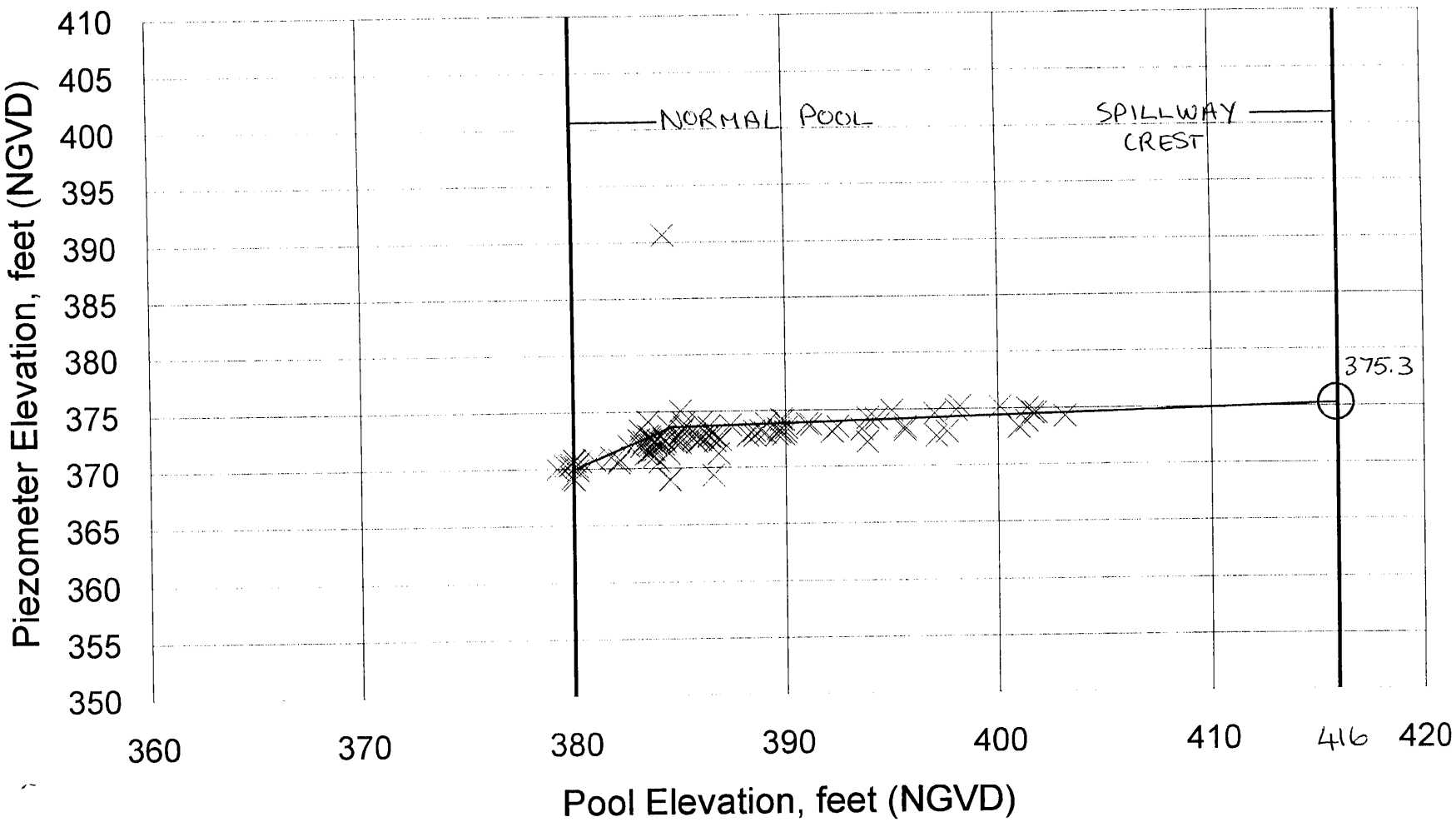
Piezometer Elevation vs. Pool Elevation
PZ-10



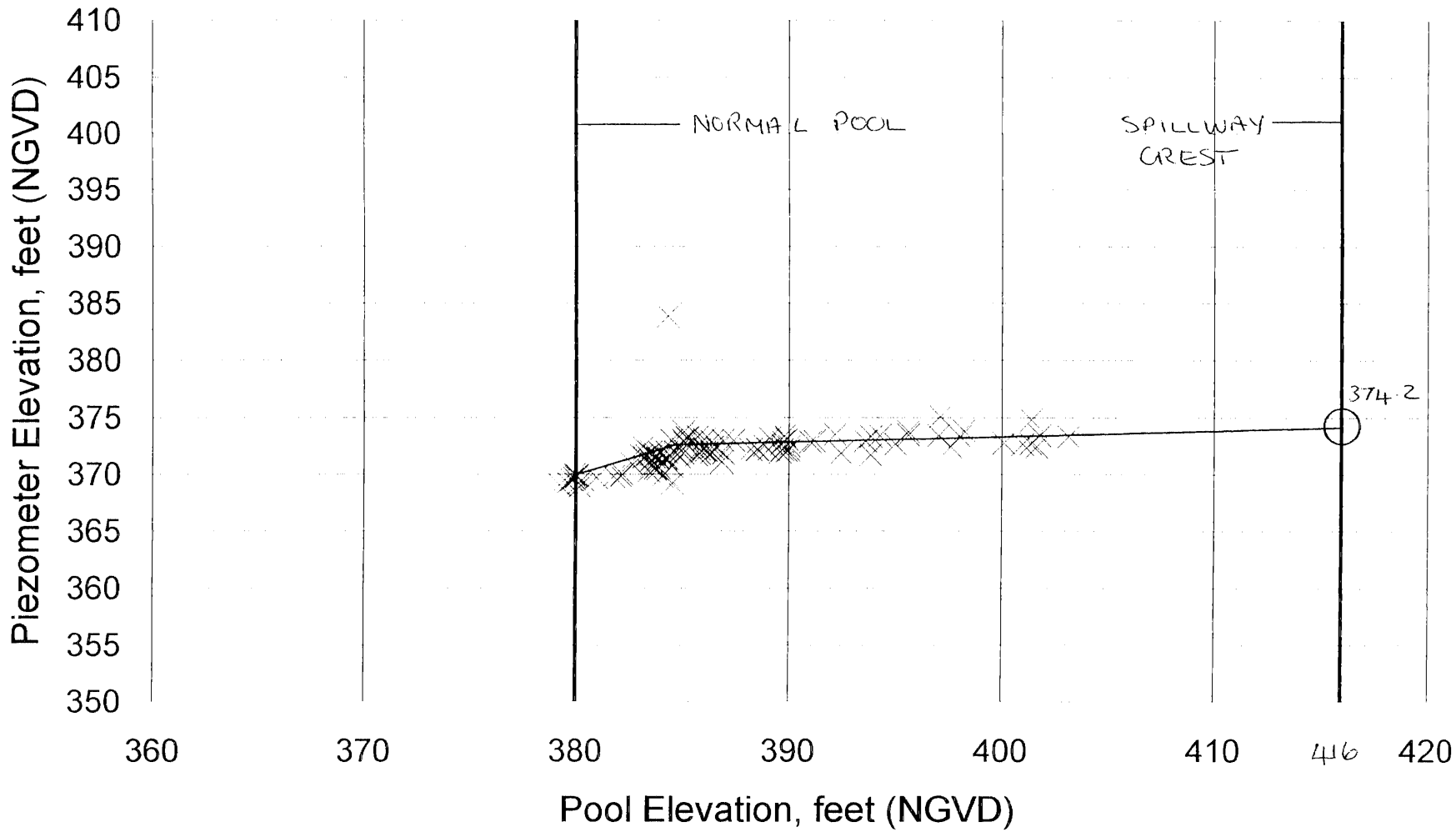
Piezometer Elevation vs. Pool Elevation
PZ-11



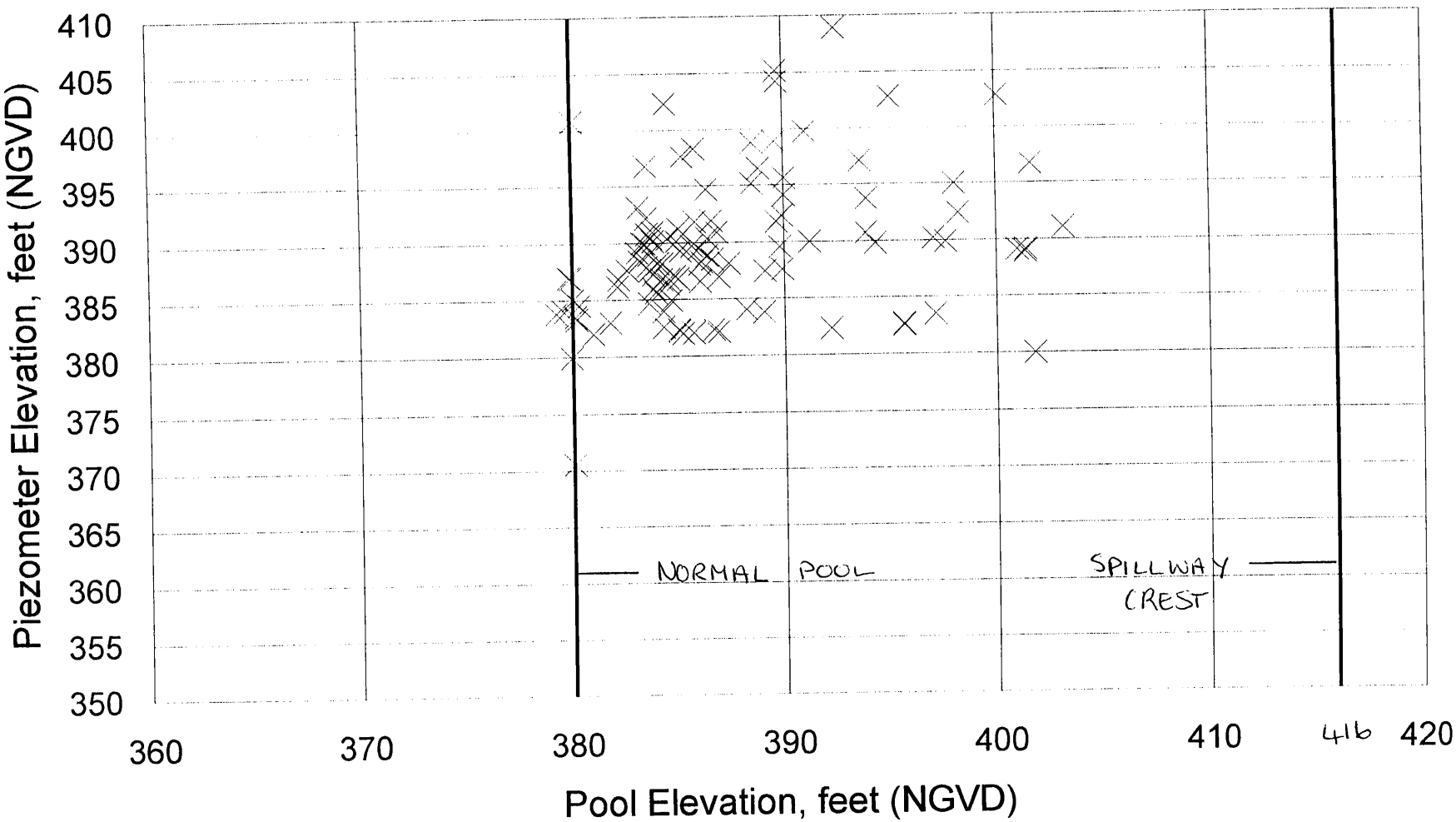
Piezometer Elevation vs. Pool Elevation
PZ-13A



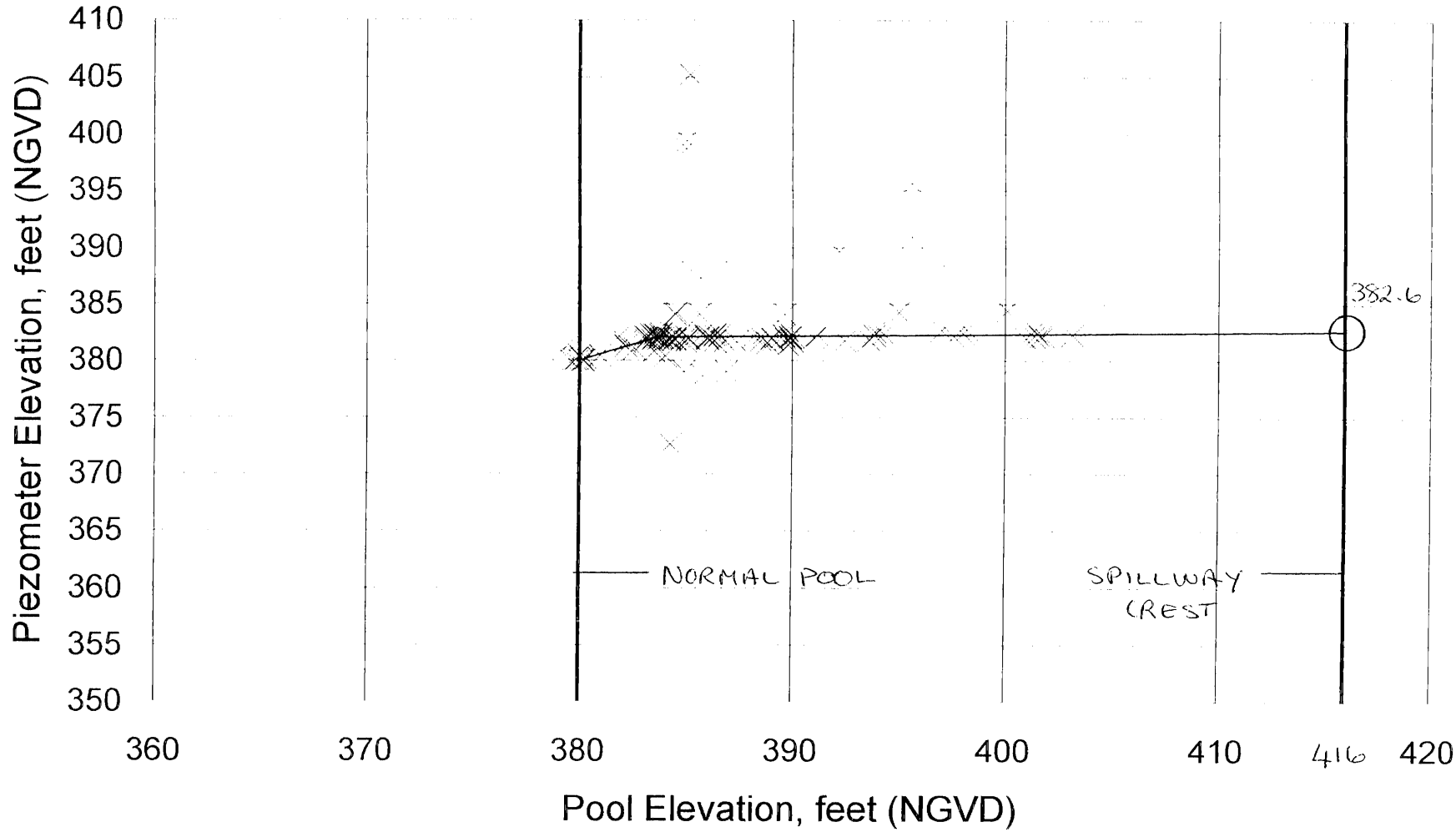
Piezometer Elevation vs. Pool Elevation
PZ-14A



Piezometer Elevation vs. Pool Elevation
PZ-13B

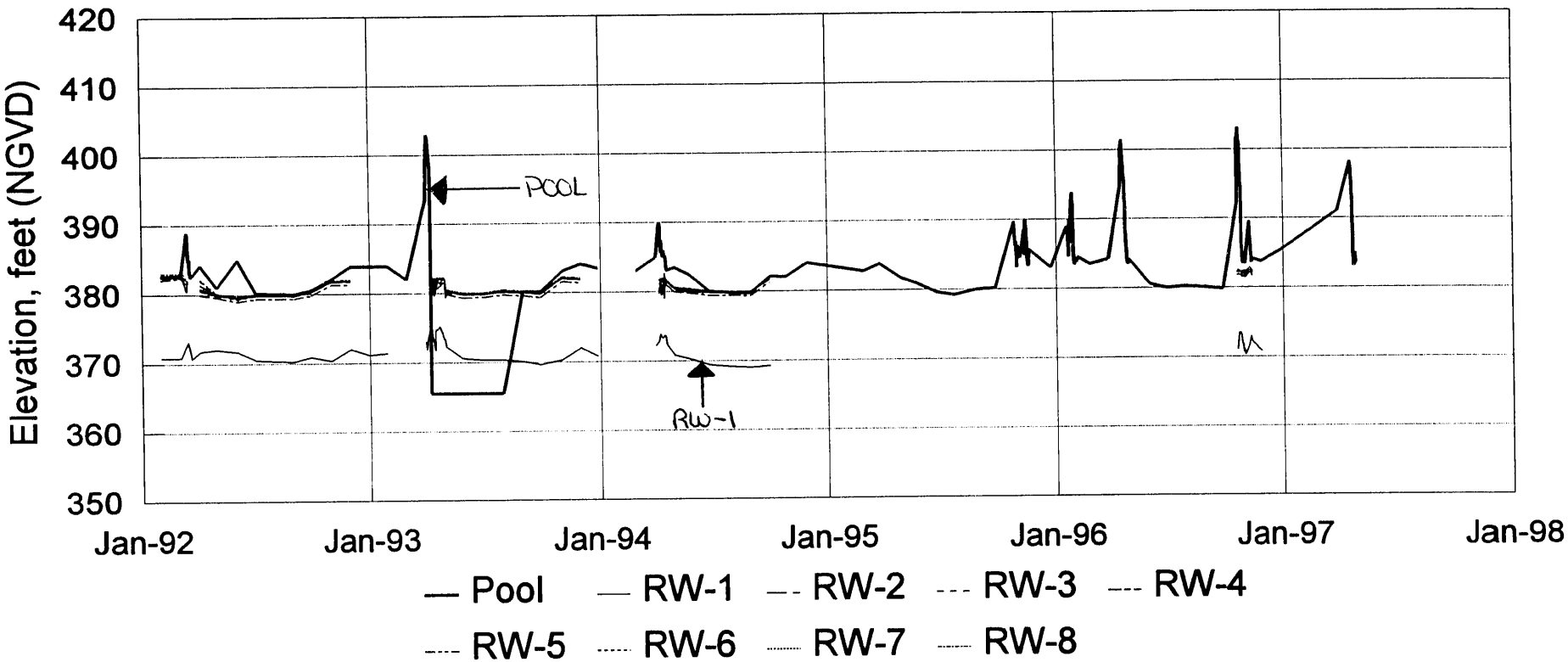


Piezometer Elevation vs. Pool Elevation
PZ-14B



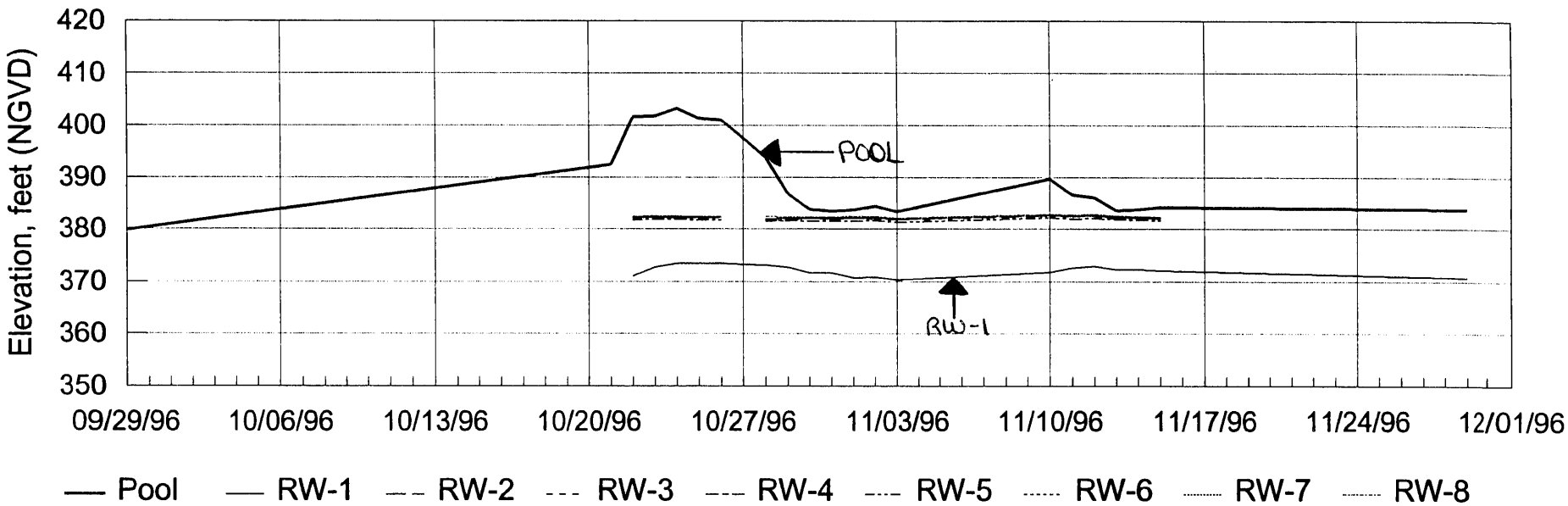
Piezometer Time History

Pool, RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, AND RW-8



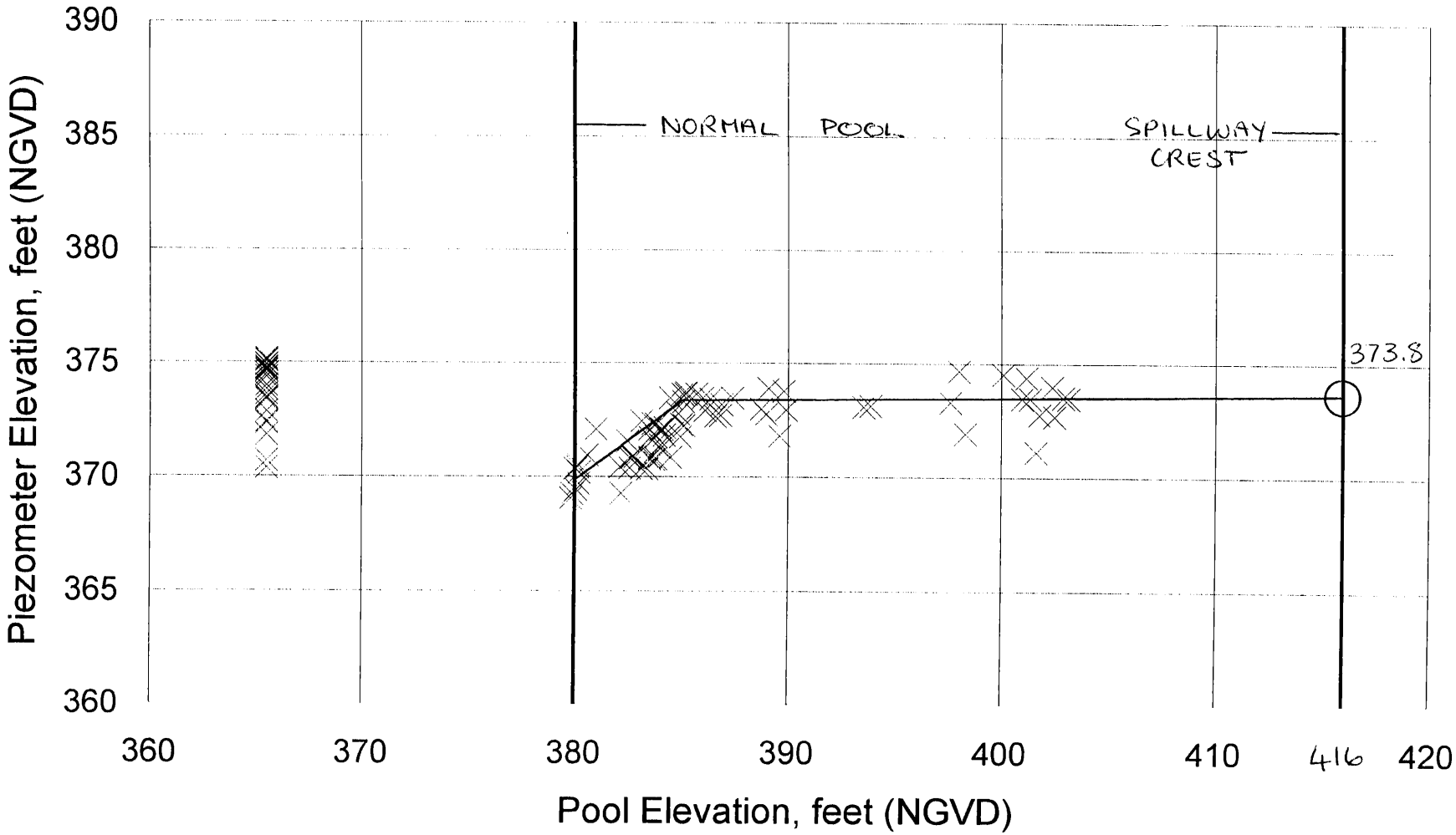
Note: Elevations at RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8 were similar, therefore these lines plot on top of each other

October 1996 High Pool Event
Pool Elev, RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8

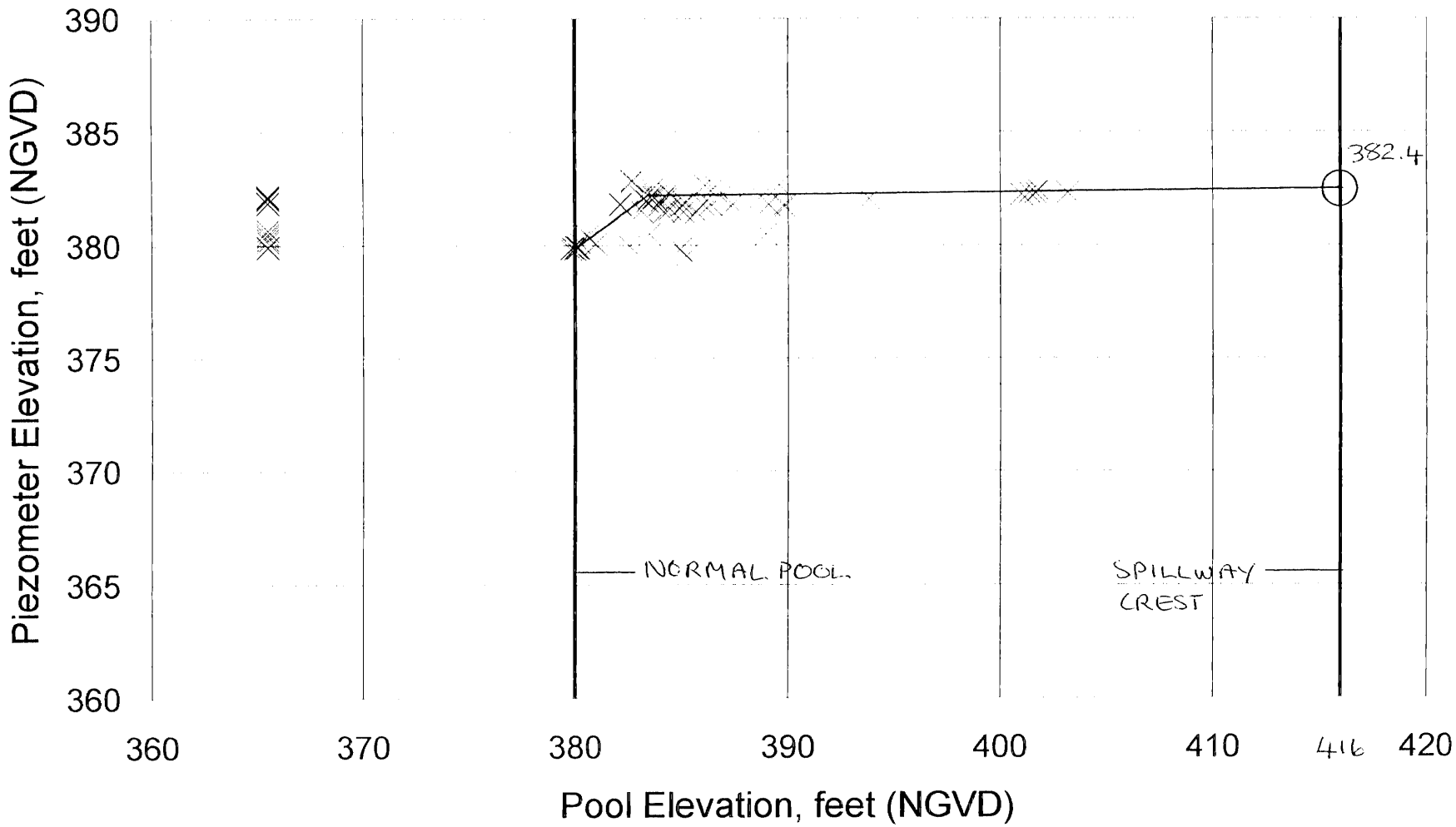


Note: Elevations at RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8 were similar, therefore these lines plot on top of each other

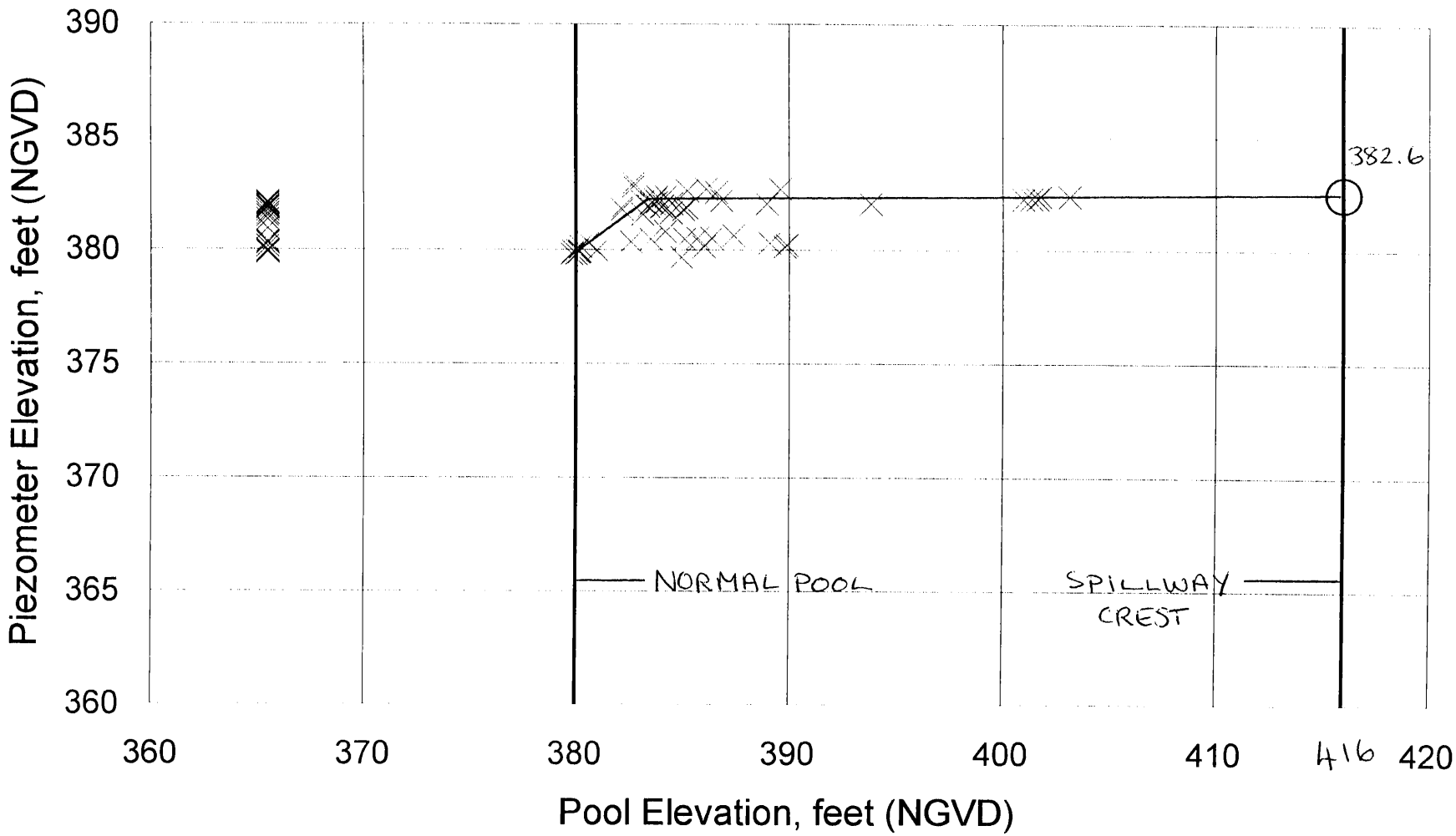
Piezometer Elevation vs. Pool Elevation
RW-1



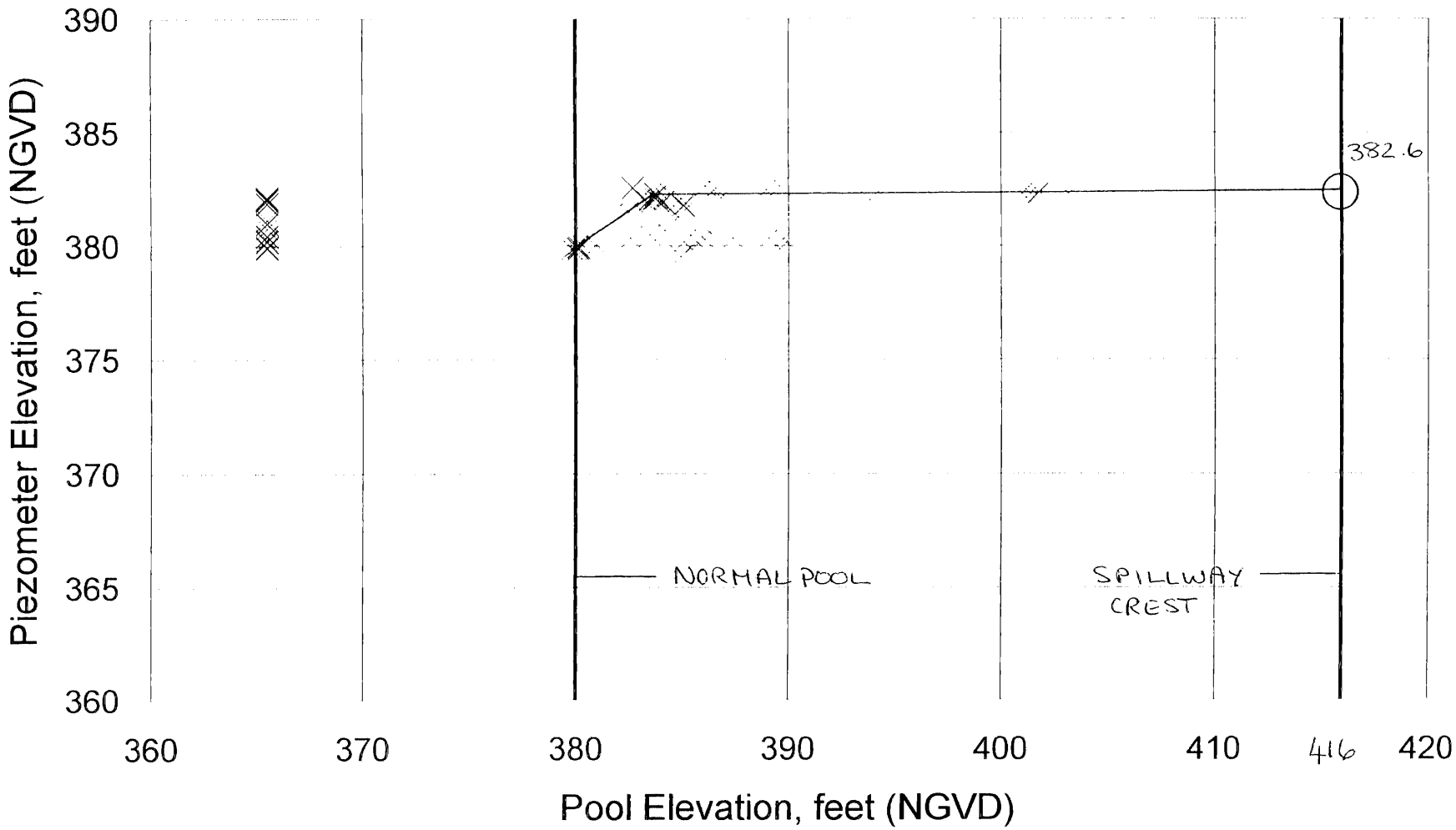
Piezometer Elevation vs. Pool Elevation
RW-2



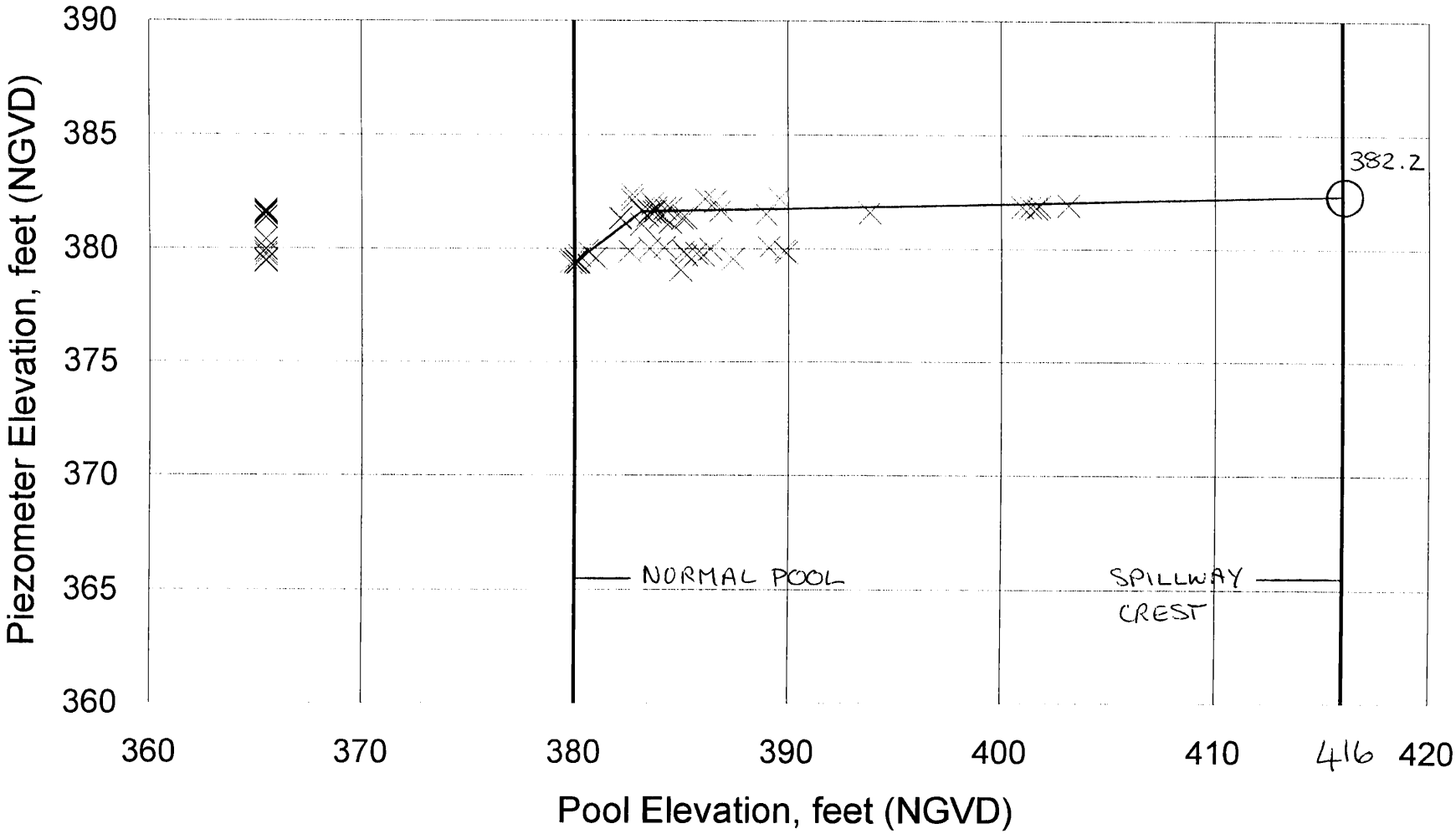
Piezometer Elevation vs. Pool Elevation
RW-3



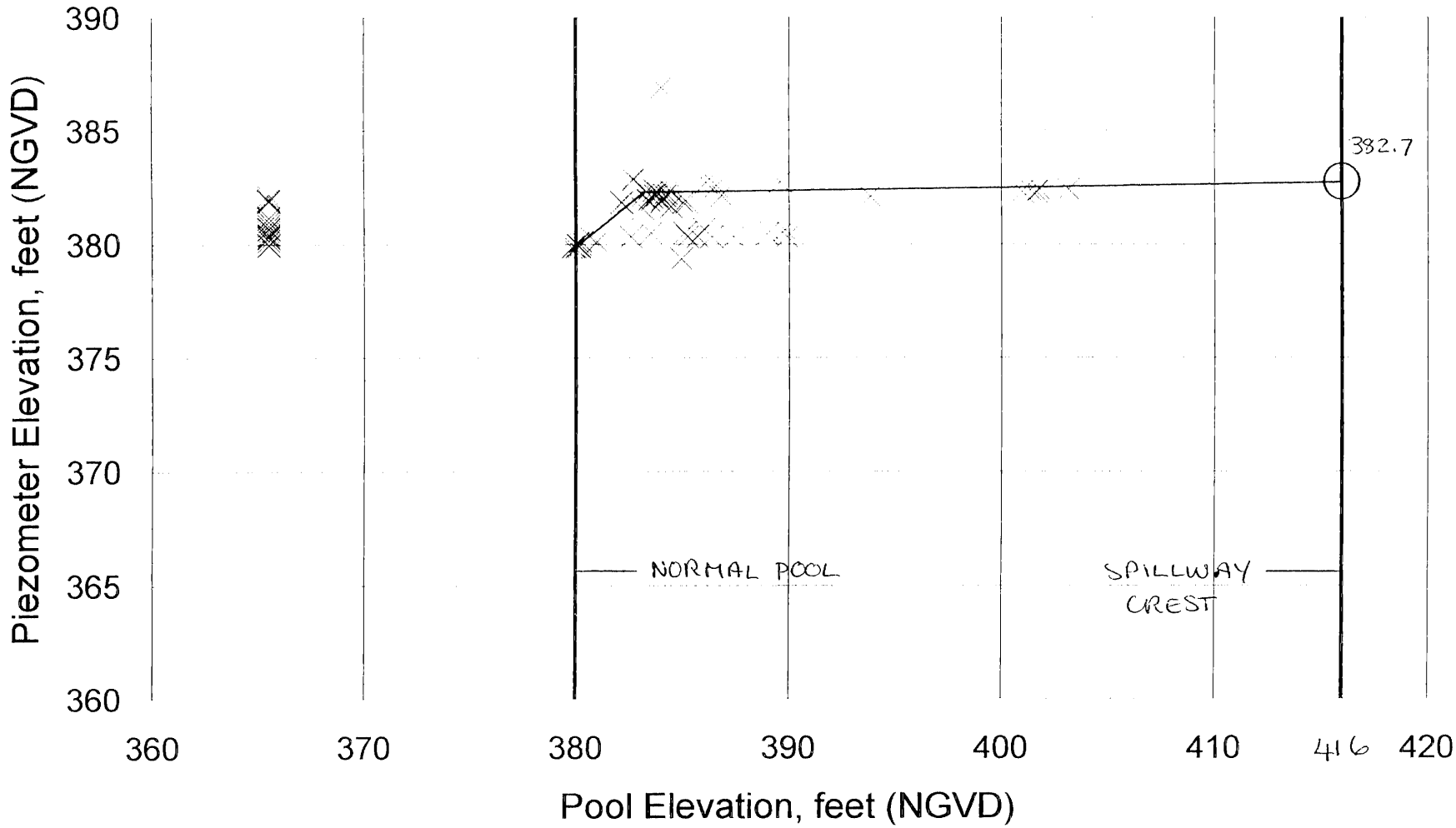
Piezometer Elevation vs. Pool Elevation
RW-4



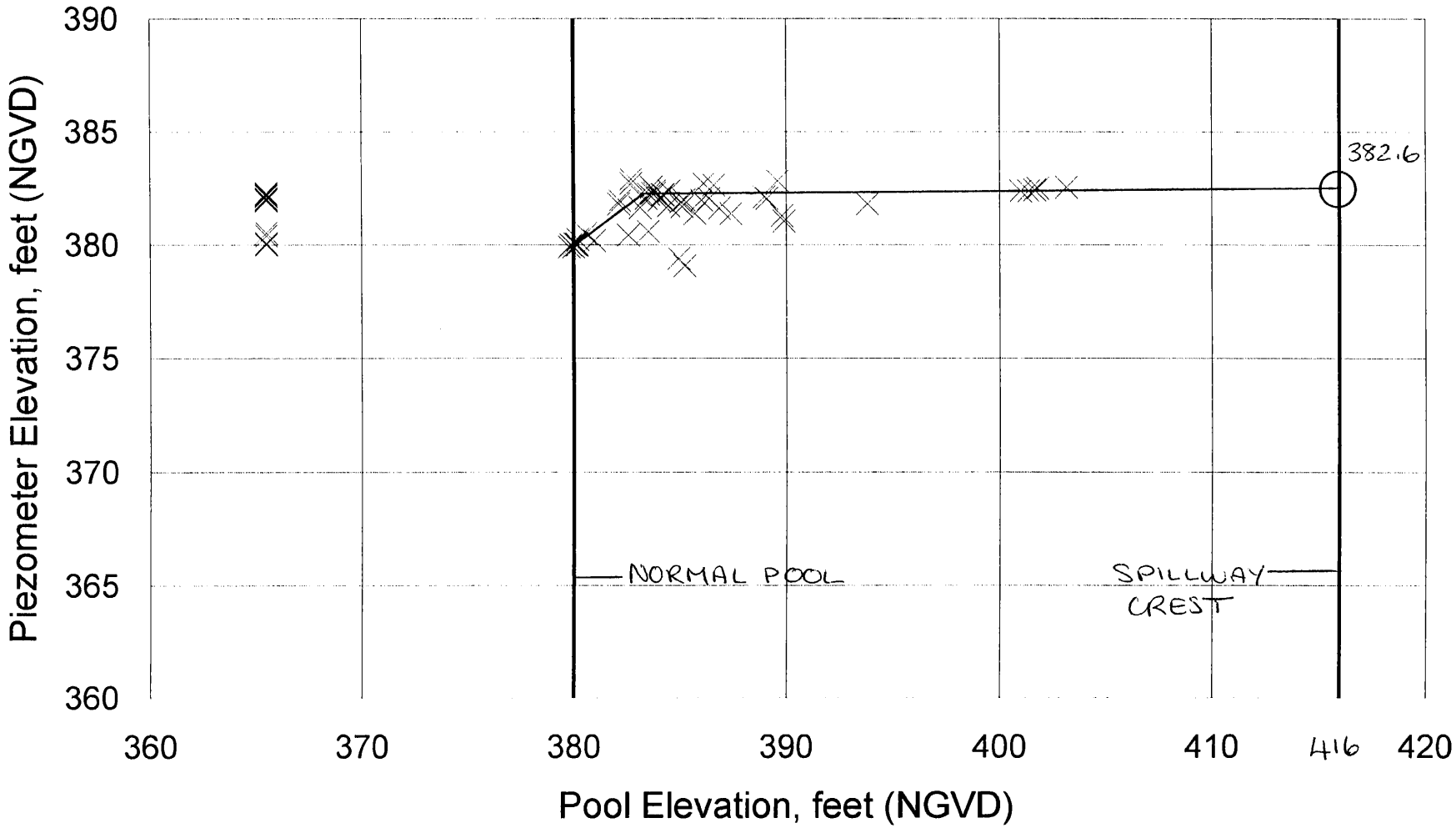
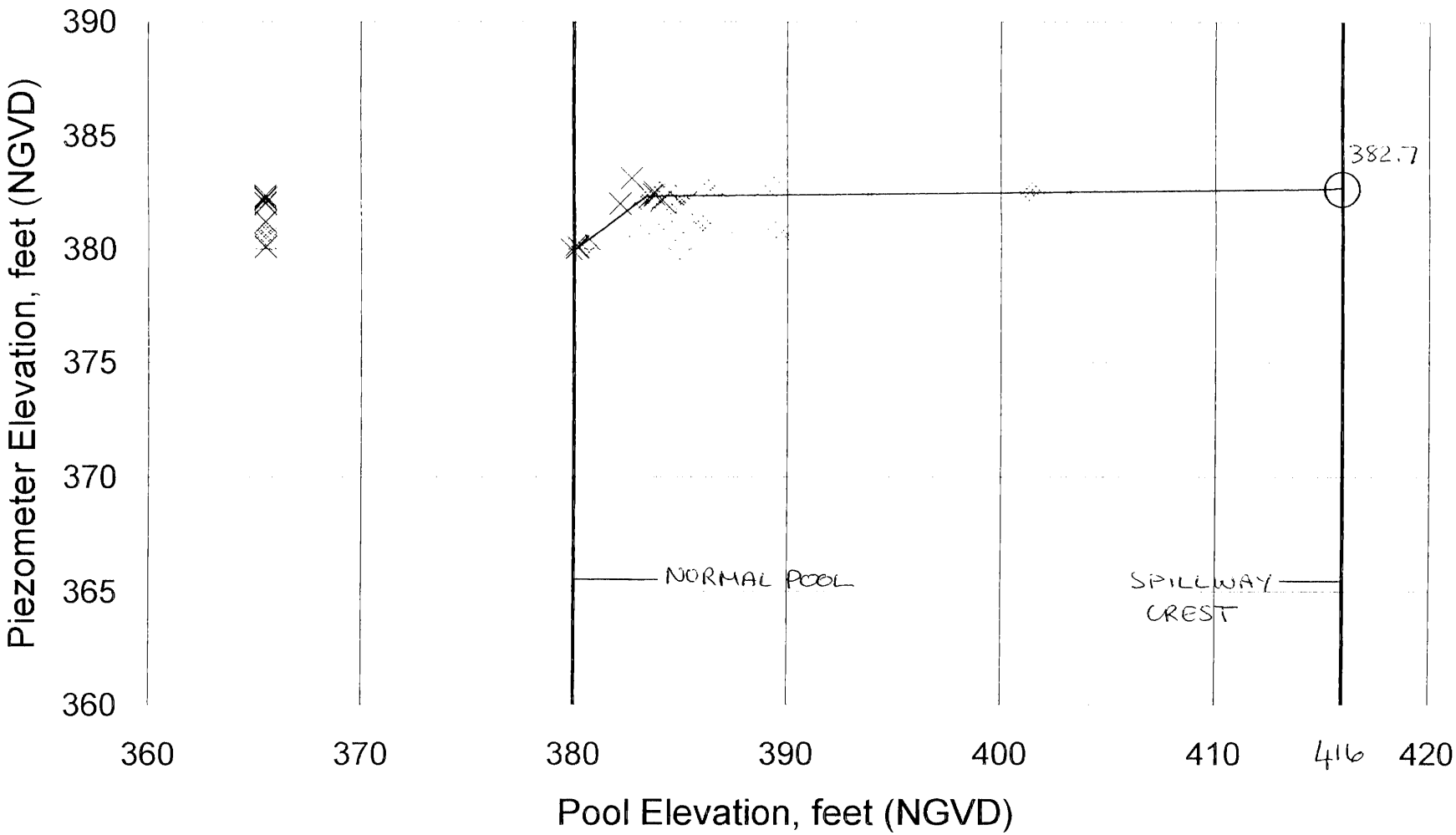
Piezometer Elevation vs. Pool Elevation
RW-5



Piezometer Elevation vs. Pool Elevation
RW-6



Piezometer Elevation vs. Pool Elevation
RW-7



Piezometer Elevation vs. Pool Elevation
RW-8